



ARMSTRONG

THE RCRA WASTE ANALYSIS PLAN

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THE RCRA WASTE ANALYSIS PLAN

INTRODUCTION

Purpose

This technical report provides guidance to installation level environmental officials, both Bioenvironmental Engineering Services (BES) and Environmental Flight Personnel, in writing and coordinating a waste analysis plan (WAP) that meets the requirements outlined in Title 40, Code of Federal Regulations (CFR), and the various United States Air Force (USAF) regulations and policy governing the hazardous waste management program.

Background

The importance of obtaining high-quality waste sampling data has increased dramatically in the past decade. Sophisticated and complex procedures have been developed which must be followed to produce high quality, defensible waste sampling data. Decision makers allocate millions of dollars in resources based on data provided by USAF environmental professionals. Therefore, ensuring consistently high quality data is extremely important.

Bioenvironmental Engineering Services (BES) at USAF installations is normally tasked with sampling and characterizing wastes, usually for disposal. Issues sample collectors should address in a high quality waste sampling program are discussed in this report. Waste analysis plans, a waste management tool required for compliance with the Resource Conservation and Recovery Act (RCRA) and USAF Hazardous Waste Management Policy, are discussed at length.

Conducting proper waste sampling is a complex issue. A significant amount of planning is required. Extensive training of sample collection personnel is a must. Large quantities of equipment and resources are needed. And, in the end, a daunting amount of documentation will be generated. The following two paragraphs are printed on the back cover of Keith (1988). They contain an eloquent description of the reasons for and the complex issues associated with waste sampling.

“Sampling is an attempt to choose and extract a representative portion of a physical system from its surroundings. Environmental sampling for chemical analysis is a complex subject that has had less status than analytical methods. But sampling itself is a vitally important issue. That which cannot be reliably sampled is seldom worth the care and expense of analysis. Furthermore, the best analytical technique cannot compensate for unreliable samples.

Samples are taken for a number of reasons, including monitoring, regulatory activities, quality control, scientific study, disaster assessment, or just idle curiosity. Generally, the objective is to take representative samples of a system or materiel of interest so that decisions can be made concerning the entire system. But this objective can be complicated by many factors. Sample data contain a degree of uncertainty, and this uncertainty must be considered

whenever the data are used. Other complicating factors include the complexity of the matrix (e.g., water; air; biota; or solids, sludges, and liquid wastes), interferences introduced during transportation and storage before analysis in the laboratory, and instability of the analytes of interest in the sample. No wonder sampling is often considered to be the weakest part of planning, sampling, analysis, and reporting activities."

The Resource Conservation and Recovery Act (RCRA) was passed by the Congress of the United States in 1976 (42 USC 6901 et seq.). The title of the act itself gives an indication of the intent of Congress in passing the act. Resource recovery, recycling, and use minimization were on the minds of many lawmakers during the time when the act was written. Little did they know, however, the huge impact this piece of legislation and its amendments would have on business and industry in the United States. RCRA created the so-called "cradle to grave" concept for waste management. Congress has amended RCRA twice, in 1980 (PL 96-482) and in 1984 (PL 98-616).

RCRA has become one of the premier pieces of environmental legislation. The cumulative cost to the US economy for implementation of RCRA has reached tens of billions of dollars, and continues to rapidly grow. In the USAF, several hundred personnel spend much of their time on RCRA compliance, which costs the USAF several million dollars each year. Waste sampling and analysis can be the largest single line item cost in hazardous waste disposal. A single hazardous waste sample can cost anywhere between \$500 and \$2000 to analyze, and we can expect this cost range to increase over the next few years. As such, it is an absolute requirement that we manage hazardous wastes in such a way as to completely comply with regulatory requirements, but keep waste analyses to the absolute minimum required.

One of the primary vehicles to minimizing waste analyses costs is the waste analysis plan (WAP) that is required under the RCRA rules, as listed in Title 40 of the Code of Federal Regulations, Part 260 and following. Without a comprehensive WAP, installations could be spending precious environmental compliance dollars needlessly. An effective WAP will identify all known RCRA regulated waste streams on an installation, list required analyses of each with the required sampling frequency, and contain historical data on each waste stream. In this way, duplicative and unnecessary samples are eliminated, and only the required analyses are performed.

Currently, pollution prevention and waste minimization are two of the environmental "buzzwords." A comprehensive WAP can be an important segment of an installation's approach to minimizing hazardous wastes and preventing environmental pollution.

Scope

This report lists and discusses the requirements for a waste analysis plan, lists information that should be included in the plan, and presents the shell of a sample installation level waste analysis plan.

DISCUSSION

Literature Review

National Hazardous Waste Policy Statement

In RCRA, the Congress of the United States outlined, in Sec. 1003(b), the following: "NATIONAL POLICY.-The Congress hereby declares it to be the national policy of the United States that, wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste that is nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment."

Department of Defense and USAF Regulatory Requirements

AFR 91-9, paragraph 4d, requires BES to "maintain surveillance over potential environmental contamination from Air Force facilities," to "assist the BCE [Base Civil Engineer] with compliance monitoring," and to "conduct periodic evaluations to see if the pollution control facilities are complying with applicable standards. Gives a copy of monitoring and evaluation reports to the BCE." These, in conjunction with the requirements outlined in AFR 19-7, are the driving regulatory force behind the BES installation environmental monitoring program.

AFR 19-11 outlines policies and responsibilities for the overall USAF hazardous waste management program. In paragraph 7, the USAF Surgeon General is tasked with providing policy for installation BES in "evaluating industrial processes and identifying waste streams subject to hazardous waste management." USAF/SG is also tasked with ensuring that installations "develop an adequate waste sampling and analysis program to comply with regulatory requirements for hazardous waste treatment, storage, and disposal [TSD] facilities." The Bioenvironmental Engineer (BEE) is tasked, in paragraph 20, to identify hazardous wastes and to ensure that permit required environmental monitoring is accomplished, to include needed waste analyses.

This guidance was supplemented, in excruciating detail, in the USAF Vice Chief of Staff's 6 June 1991 letter "Air Force Hazardous Waste Management Policy." Notably, this policy requires that a waste stream inventory and a waste analysis plan be included as sections 8 and 9 of the installation hazardous waste management plan (HWMP). Hazardous waste characterization information is to be documented on the DRMS Form 1930, Hazardous Waste Profile Sheet (HWPS), regardless of whether the local Defense Reutilization and Marketing Office (DRMO) is the disposal agent. The BES is designated as the office of primary responsibility (OPR) for the waste stream inventory and waste analysis plan. The BES is also designated as the office that will collect, prepare, and arrange for shipping hazardous waste samples to "an approved analytical laboratory for analysis." However, what constitutes an approved laboratory and who is the approving official are not listed.

The hazardous waste (HW) inventory "contains a description of the HW streams generated" at each installation. As a minimum, it must contain the generator, the location, the waste stream number, and a waste characterization for each identified HW stream. The waste characterization must include a description of the waste, analytical data, appropriate U.S. Environmental Protection Agency (EPA) and/or State HW identification codes, the U.S. Department of Transportation (DOT) proper shipping description, the quantity generated, and type of accumulation (i.e., how the waste is stored).

Each installation that generates HW must have a WAP that complies with the requirements outlined in 40 CFR 261, 264, and 268. Procedures for identifying all potential HW streams must be in the WAP. Analytical and other procedures for determining if wastes are indeed a HW are required. In addition, "the WAP should specify HW sampling methods, sample analysis location, analytical methods used, sample documentation (including chain-of-custody where applicable), sample quality assurance/quality control and procedures for generating activities to follow to request sampling for new or uncharacterized waste streams. The WAP should also include a description for periodic reevaluation of each waste stream based on the volume generated in a year. The WAP "should include a quality control program to ascertain whether the waste stream has substantially changed, thus requiring re-characterization."

Notably, the USAF policy tasks the HW generator with ensuring characterization of the waste stream using the DRMS Form 1930. The characterization can be based on user/generator knowledge or chemical analysis. The generator is also tasked with requesting analytical support through the installation environmental function. The installation environmental manager is tasked as "the focal point for coordinating the required HW analysis in support of the HWPS." A copy of the HWPS should be on file in the environmental office and in BES (in the generating activity's shop folder). The policy also dictates compliance with the requirements in the land disposal restrictions (LDRs) in 40 CFR 268 concerning waste analysis. The LDRs also require generators to retain documentation for 5 years concerning the methods of waste characterization, and where the waste was treated, stored, and disposed.

Overseas Environmental Baseline Guidance Document (OEBGD) Requirements

In general, the guidance in the OEBGD tracks closely with the RCRA rules contained in 40 CFR. However, the OEBGD is far less detailed than the 40 CFR rules. The following paragraphs contain several of the requirements listed in the OEBGD which may slightly differ from the 40 CFR rules.

Generators of hazardous waste (for the purposes of the OEBGD, the installation or DoD activity generating the waste is considered the generator) must "identify and characterize the wastes generated at their site using their knowledge of the materials and processes which generated the waste or through laboratory analysis of the waste. A Hazardous Waste Profile Sheet [DRMS Form 1930] will be used to identify each hazardous waste stream." The OEBGD requires that the installation maintain a file of profile sheets for "each waste stream handled," and include "procedures for characterization and verification testing of both on-site and off-site

hazardous waste." The generator is also required to "conduct periodic verification testing" of wastes in storage in an installation's Hazardous Waste Storage Area (HWSA).

Waste Analysis and Characterization Records, i.e., profile sheets and sampling documentation and results, must be retained "until 3 years after closure." Closure here indicates discontinuation of the use of a specific HWSA on an installation.

Specific RCRA Requirements for the Waste Analysis Plan

Generators of solid waste must determine if the generated solid waste is regulated as a hazardous waste (40 CFR 262.11). 40 CFR 264.13 requires that the operator of a TSD facility have a WAP, to include a "detailed chemical and physical analysis of a representative sample of the waste." If the waste is deemed potentially hazardous and is not a listed hazardous waste, testing to determine if the waste meets any of the characteristics listed in 40 CFR 261 is required. In addition, the generator is required to determine if the waste is land disposal restricted (40 CFR 268.7). Several requirements are outlined in 40 CFR 264.13. These are summarized in the following paragraphs.

1. The waste analysis may contain data generated from sources other than laboratory analyses.
2. The analysis must be repeated as necessary to ensure accuracy and timeliness. It must be repeated when process or operational changes alter the waste characteristics, or when waste received from off-site does not match the designation on the accompanying manifest.
3. The WAP must specify, as a minimum:
 - a. The parameters for which each waste will be analyzed and the rationale for the selection of these parameters (i.e., how analysis for these parameters will provide sufficient information on the waste's properties to comply with 264.13(a)).
 - b. The test methods to be used for these parameters.
 - c. The sampling method which will be used to obtain a representative sample of the waste to be analyzed. A representative sample may be obtained using either one of the sampling methods described in Appendix I of 40 CFR 261 or an equivalent sampling method.
 - d. The frequency with which the initial analysis of the waste will be reviewed or repeated to ensure that the analysis is accurate and up to date.
 - e. For off-site facilities, the waste analyses that HW generators have agreed to supply.

f. Where applicable, the methods that will be used to meet the additional waste analysis requirements for specific waste management methods specified elsewhere in 40 CFR 264 and 268.7.

g. For off-site facilities, the procedures which will be used to inspect and, if necessary, analyze each movement of hazardous waste received at the facility to ensure that it matches the identity of the waste designated on the accompanying manifest or shipping paper. Minimally:

(1) The procedures which will be used to determine the identity of each movement of waste managed at the facility; and

(2) The sampling method which will be used to obtain a representative sample of the waste to be identified, if the identification method includes sampling. Representative sampling methods are listed in Appendix I to 40 CFR 261. Containerized liquid wastes are sampled with the containerized liquid waste sampler, or COLIWASA. Liquid wastes in pits, ponds, lagoons, and similar reservoirs are sampled with a pond sampler. Non-liquid wastes are typically sampled using augers, coring tools, shovels, etc. SW-846 contains detailed instructions on statistically valid sampling methodologies.

Waste Oil Analysis

Standards for the Management of Used Oil, 40 CFR 279, contains several provisions which must be considered in designing a WAP. Notably, analysis requirements for used oil are listed (see Appendix D). As used oil will be a significant RCRA waste stream on each installation, proper management of this waste stream is imperative. Requirements for analyzing used oil should be included in a comprehensive WAP.

As the emphasis shifts from disposal to reuse/recycling the energy recovery analysis is becoming more and more popular. The regulatory limits and uses for this analysis are listed in 40 CFR 279 (with the exception of PCBs and major components--AL recommends these analyses in addition to those listed in 40 CFR 279). This analysis includes total metals for arsenic, chromium, cadmium, and lead; total halogens; PCBs; ignitability; and major components. This test should be requested on all nonphased POL wastes. This analysis will give your disposal facility the needed information to safely burn the material in a licensed incinerator.

Planning for Waste Sampling

The following paragraphs summarize the elements of a complete sampling plan. Outlining specifics for individual waste sources is beyond the scope of this paper, but the reader should refer to the myriad publications available, many from USEPA, concerning sampling.

Specify sampling procedures, locations, equipment, and sample preservation, handling, and shipping requirements in the sampling plan. Spell out chain-of-custody procedures as necessary.

Address, as a minimum, the issues outlined in the following paragraphs. Alternately, write BES operating instructions covering these issues. Section 3.0, FIELD OPERATIONS, in chapter one of SW-846, summarizes QA/QC activities associated with field sampling. This section starts with the following sentence: "The field operations must be conducted in such a way as to provide reliable information that meets the DQOs [Data Quality Objectives]." All BES Chiefs and NCOICs should be familiar with this document and ensure that their sampling procedures adequately address the QA/QC and DQO issues discussed in FIELD OPERATIONS.

Definition of objectives: Briefly state the reasons the sample or set of samples is being collected. State regulatory or permit requirements if there are any. Previous trends at a particular sampling location may be the driving force for sampling. Thoroughly explain and logically support your reasoning.

Design of sampling protocols: SW-846 contains a brief but thorough discussion of sample collection and preservation procedures. A thorough sampling protocol contains many elements, such as the exact sampling location, sampling equipment needed, sampling frequency, analytes of interest, sampling procedures, randomization technique utilized (as applicable), points of contact at the sampling site, etc. The sampling protocol should be sufficient for completion of the sampling event without needing another information source.

Several suggested field sampling protocols are in the literature. Because of widely varying possible waste sampling requirements, outlining a generally applicable protocol is difficult. Barcelona (1988) presented the outline of a generalized sampling protocol which is applicable to the majority of waste sampling plans. He listed seven points, each with a number of subelements. Table 1 from his paper is reproduced below.

Table 1. Outline of Generalized Sampling Protocol (After Barcelona, 1988)

MAIN POINT (PROGRAM PURPOSE)	SUBELEMENTS
Analytes of interest	Primary and secondary chemical constituents and criteria for representativeness
Locations	Site, depth, and frequency
Sampling points	Design, construction, and performance evaluation
Sample collection	Mechanism, materials, and methodology
Sample handling	Preservation, filtration, and field control samples
Field determinations	Unstable species and additional sampling variables
Sample storage and transport	Preservation of sample integrity

He also made the following statement concerning sampling and environmental monitoring efforts:

"The goals or purposes of an environmental program or study are implicit in the task of sampling protocol preparation. The cost, time frame, and overall goals of a particular study may override efforts to carefully plan and conduct an adequate sampling operation.

However, the long-term consequences of the quick answer should be considered. Environmental scientists can also argue that the cost of planning and conducting a limited sampling experiment can save considerable expense as well as 'face' in studies that deal with trace chemical constituents of health concern. All individuals involved in the effort should understand the overall and immediate purposes of the study and recognize that the data must be well-documented as to quality."

Preparation of containers and equipment, and maintenance, calibration, and cleaning of field equipment: Utilize only precleaned sample containers, i.e., Level II certified containers. These are available from several companies. These containers have been washed in compliance with EPA protocols, and are suitable for waste samples, bulk samples, water samples, and wastewater samples. Sample collection equipment must also be cleaned appropriately. Usually, a soap and water wash with a thorough rinse adequately cleans sample collection equipment. Rinsing with an organic solvent (such as isopropanol or hexane) may be necessary if trace organics are the analytes of interest. If significant metal concentrations are expected, acid rinsing of sample collection equipment may be necessary. Refer to instrument user's manuals for procedures for calibrating field instruments.

Sample preservation, packaging, and shipping: This information is covered fairly thoroughly in the sampling guide. List and explain any variations to published guidance. Coordinate shipping requirements with local Transportation Squadron personnel prior to the sampling event. Educate shipping officials on the critical requirements for expeditious shipping of waste samples, since there are some extremely short holding times for some analyses.

Health and safety protocols: Detail these procedures in the sampling plan, no matter how inherently and intuitively obvious they may seem. Document training via annotations on the AF Form 55 of affected personnel. Refer to the USEPA Standard Operating Safety Guides for excruciatingly detailed information on health and safety procedures for waste sampling.

Chain-of-custody protocols: Chain-of-custody procedures are used much more than they were a few years ago. A sample chain-of-custody form is in the AFOEHL Sampling Guide. However, USAF shipping personnel (Packing and Crating in the Transportation Squadron) have no regulatory guidance on using these forms. We have received these forms packed inside the sample container. During a 1993 visit to Detachment 3, AL by an EPA official, he indicated that this was not adequate for legal purposes. He indicated that the form must be signed off by all persons who handle the samples, including packing, shipping, and receiving personnel. There is no easy solution to this issue short of a regulation change or a policy directive from MAJCOM. If you must ship samples using chain-of-custody procedures, work with your local shipping office to educate them on the needs for these procedures and how the form should be affixed to the exterior of the package. Also, please telephone coordinate with the servicing analytical laboratory and tell them that samples with chain-of-custody requirements are on the way.

Analytical Laboratory QA/QC: BES should be aware of the QA/QC procedures used at the selected analytical laboratory. Send samples only to laboratories certified by competent state or

federal authority or, for overseas installations, laboratories that follow USEPA approved QA/QC procedures and use USEPA approved analytical methods.

Blanks and Standards

BES offices regularly submit blank filters (charcoal, matched-weighted, etc.) when they perform personal air sampling. However, blanks associated with environmental sampling are a relative rarity. This can invalidate the sampling results. The following comments were made by Barcelona, (1988): "Field blanks and standards enable quantitative correction for bias (i.e. systematic errors), which arise due to handling, storage, transport and laboratory procedures. ...Field blanks, standards and blind control samples provide independent checks on handling and storage as well as the performance of the analytical laboratory. It should be noted that ground-water analytical data is incomplete unless the analytical performance data (e.g., accuracy, precision, detection, and quantitation limits) are reported along with each set of results. ...Well planned quality control programs will also minimize the uncertainty in long-term trends when different personnel have been involved in sample collection and analysis."

At Det 3, AL we have received some drinking water samples that exceeded maximum contaminant levels (MCLs). We traced the cause to contaminated acid used to preserve the samples. Analytical results from blanks can indicate contamination of sample containers, sample collection equipment, and/or shipping containers. There are several different types of blank, duplicate, or spike environmental samples. For aqueous samples, you should use reagent grade water as a blank matrix. For solids, there is no universal blank matrix, therefore, no matrix is used. Use only reagent grade chemicals to preserve samples.

Field blanks: Use a portion of analyte-free water (or other liquid matrix for sample collection) brought to the sampling location in sealed containers and shipped to the laboratory with the sample containers.

Trip blanks: These are not opened in the field. Use them to check for contamination resulting from problems during sample transport, shipping, and/or from site conditions.

Preservative blanks: This sample is prepared in the laboratory by using analyte-free water which is preserved as a sample and shipped with the other samples. A different preservative blank is necessary for each preservative (acid or base) used for samples shipped together.

Equipment blanks: Open these in the field and pour the contents (analyte-free water) over and/or through sample collection equipment. Collect this 'rinsate' and treat as another sample. These samples aid in checking the cleanliness of sample collection equipment.

To the extent possible, the blank samples should be submitted such that the analytical laboratory can not easily detect that the particular sample is a blank. This helps to ensure that the laboratory treats blank samples in the same fashion as the actual environmental samples.

Results of split samples (i.e., duplicates) are a check on the internal QA/QC of the analytical laboratory as well as the consistency of the sample collection team. If results of duplicate samples are notably different, the environmental matrix should be immediately resampled and the analytical laboratory notified of the seeming inconsistency. Investigate all procedures, both in the field and in the laboratory to determine the cause of the inconsistent results. Send split samples to different analytical laboratories to identify inconsistencies in analytical techniques.

Documentation Review

After environmental sampling has occurred and relevant analytical reports have been reviewed, BES should review the records and evaluate the following.

Documentation Completeness: Determine that detailed and complete records exist to adequately define the sampling event. As a minimum, the records should be such that a competently trained technician from another installation could fully recreate the sampling event.

Sample Validity: The Chief or NCOIC of BES should review the records to identify gaps or problems with the records that might affect sample validity. There are many issues which could invalidate samples, such as incorrect collection, preservation, or shipping of samples.

Data Correlation: Ask yourself if the data make sense in light of field observations, knowledge about the process, etc. Laboratories don't make very many mistakes (i.e., getting samples mixed up), but if they go undetected, the end result could be catastrophic.

Anomalous Field Test Data: Review all analytical data, both field and laboratory generated. Note inconsistencies in the data and their impact on sample validity. Document and explain as necessary.

Field Data Validation: Review all data derived from field analyses (either in situ or from field laboratories) and determine if there are problems with the data that may invalidate or call into question the results of the sampling event.

The Waste Analysis Plan

"The objective of a waste analysis plan is to describe the procedures that will be undertaken to obtain sufficient waste information to operate a hazardous waste management facility in accordance with its permit (i.e., to ensure that wastes accepted by the facility fall within the scope of the facility's permit, and that the process performance standards are met). The waste analysis plan establishes the hazardous waste sampling and analysis procedures that will be routinely conducted as a requirement of the RCRA permit." (USEPA, 1984)

A minimal WAP must contain information on analytical parameters and methods, and sampling methods and frequency. However, such a plan would be largely useless for other than minimal regulatory compliance. Such elements as analysis location, sample documentation,

QA/QC procedures, procedures for evaluating new waste streams, and procedures for evaluating a waste itself are needed to make the WAP a useful management tool. No format for the WAP is specified in the RCRA rules, but Table 2 shows the suggested contents for an installation WAP. Appendix E is a sample installation level WAP. USEPA (1984) states that a WAP should answer the following four questions:

- I. What are the specific wastes or types of wastes that will be managed within each process?
- II. What are the waste-associated properties that are of concern in ensuring safe and effective management (e.g., kcal/g (Btu) content, % water)?
- III. What are the specific waste parameters that have to be quantified in order to satisfy the data needs?
- IV. How will the necessary data be obtained, including what sampling and analysis procedures, and what attendant quality control/quality assurance procedures are to be carried out by the permittee?"

Procedures for Evaluating Waste

Before an analysis protocol for a specific material is developed, the basic question of if the material in question is a waste, and furthermore a solid waste, must be answered.

1. If the answer to any of the following questions is yes, the material is a waste.
 - a. Is the material no longer useful for its intended purpose because it is dirty, out of specification, or a spill residue?
 - b. Is it an unintended or unusable byproduct?
 - c. Does the base intend to discard the material for eventual treatment, storage, recycling, or disposal?
 - d. Is it produced by cleanup at a previously uncontrolled waste site?
2. The RCRA definition of a solid waste is as follows: "...any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act as amended (86 Stat. 880), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923)."

Table 2. Elements of a Useful Waste Analysis Plan

SECTION	SUB-ELEMENTS
A. General Information	1. Requirements 2. Responsibilities 3. Installation Specific Issues 4. Update of the Waste Analysis Plan 5. How to Request Sampling/Analytical Services
B. Waste Evaluation	1. Definition of a Waste 2. Definition of a Solid Waste 3. Definition of a Hazardous Waste 4. Evaluation Procedures
C. Analytical Procedures	1. Listing of Analytical Methods and Sources 2. Justification for Analytical Laboratory Selection
D. Waste Stream Sampling Procedures	1. Waste Containerization 2. Frequency of Waste Stream Sampling 3. Specific Waste Stream Sampling Methods 4. Sample Control 5. Sampling Procedures 6. Health and Safety Protocols
E. Quality Assurance and Quality Control	1. Sampling QA/QC 2. Documentation Requirements (Field and Office) 3. Data Validation and Interpretation Procedures 4. Chain-of-Custody Requirements 5. Representative Sampling Techniques
F. Sampling Methods and Equipment	1. Listing of Equipment/Resources Required 2. References to Generalized Sampling Methods
G. References	1. SW-846 2. AFR 19-11 3. AFOEHL Sampling Guide 4. Others as necessary
H. Analytical Schemes	List Sampling and Analytical Schemes for each individual waste stream on the installation in this section. These should be written like a checklist.
I. Hazardous Waste Stream Inventory	1. Waste generator/facility. 2. Location of generator. 3. Waste stream number. 4. Waste characterization/description. This is an ideal database or spreadsheet application. Include any other information you think is appropriate.
J. Waste Stream Profiles	This section should include a copy of the DRMS Form 1930, Hazardous Waste Profile Sheet, for each waste stream on the installation. Attach sampling and analytical paperwork to the DRMS Form 1930.

3. A solid waste is a HW if:

- a. It is not excluded from regulation as a HW and;
- b. It meets one of the characteristics listed in 40 CFR 261 Subpart C (ignitability, reactivity, corrosivity, or exceeds a limiting value in the Toxicity Characteristic Leachate Procedure (TCLP)).
- c. It is a listed HW in 40 CFR 261 Subpart D.
- d. It is a mixture of a solid waste and a HW listed in Subpart D that is listed solely because it meets one of the characteristics listed in Subpart C, unless the resultant mixture does not meet one of the Subpart C characteristics.
- e. It is a mixture of solid waste and one or more HWs listed in subpart D and has not been excluded from regulation. Several specific regulatory exclusions are listed in 40 CFR 261.3.

Analytical Parameters and Methods

40 CFR 261 and SW-846 describe analytical parameters and methods for determining HW constituents. A parameter is the property or constituent you are looking for. Examples of parameters are ignitability, corrosivity, and metals concentrations. A method is the analytical procedure used to look for a constituent and/or determine a waste property. The parameters and methods for each waste stream must be clearly identified in the WAP.

Sampling

Before taking a sample, a determination as to the necessity of a sample should be made. If it is determined that a sample is required, follow the sampling methodology outlined in the WAP, remembering that analytical results are only as good as the sample. If the sample is not representative of the waste, then the results are only applicable to the sample, and not to the remainder of the waste stream. Statistically valid sampling protocols must be used for sampling waste streams. Appendix F is a copy of the USEPA Environmental Response Teams Waste Sampling Standard Operating Procedures.

Sample Quality Control and Documentation

There are statistical techniques that are relatively simple and easy to implement for obtaining accurate and precise samples. Sampling accuracy is usually achieved by one form of statistically valid random sampling. Precision is manipulated by varying the number, volume, and/or weight of the samples taken. There are various sampling references available, such as SW-846 and various ANSI standards (USEPA, 1986; ASTM D4687-87; ASTM E725-86).

In order to lower sampling and analytical costs, composite samples are often used. A composite sample is obtained by collecting a number of random samples from a waste, combining the individual samples into a single sample, and analyzing the single sample for the parameters/constituents of concern.

Chain of custody procedures should be used when samples must meet legal or permit requirements. A sample chain of custody form is included in the AFOEHL Recommended Sampling Procedures (1989).

The importance of complete field documentation cannot be over stressed. The resources invested in sampling and analysis are wasted if the accompanying data/documentation is incomplete or inaccurate. A field logbook is an important part of the document chain.

The documentation for each sample should include, minimally, the following:

1. Location of the sampling point.
2. Type of process producing the waste.
3. Physical form of the waste (solid, liquid, semi-solid, sludge).
4. Number and volume of sample(s) taken.
5. Purpose of the sampling event.
6. Description of the sampling methodology, with critical attention as to the statistical validity and representativeness of the sample(s).

Samples need not be handled as a hazardous waste (although they should be handled as potentially dangerous and toxic!) unless it is previously known that the sample is indeed hazardous. After analysis, if it is determined that the sample is hazardous, it must be handled as such.

Analysis is only as good as the laboratory and the chemist performing the analysis. The WAP should include a discussion of the capabilities and resources (and limitations, if there are any) of the analytical laboratory. The installation Bioenvironmental Engineer should ensure that the analytical laboratory has a comprehensive quality assurance and quality control (QA/QC) program in place, and that all EPA and state requirements are fully complied with. The Bioenvironmental Engineer should also be the individual designated to interpret analytical data and apply the data to waste management operations.

Updating the Waste Analysis Plan

Update of the WAP is required when:

1. When the sampling frequency changes (typically due to changes in the volume of waste generated).
2. When analytical requirements change (typically due to changes in the processes generating the waste, or to changes in disposal contracts).
3. When regulatory requirements change (i.e., EPA changes its waste code designations, etc.).
4. When disposal methods change (such as the changes caused by the land disposal restrictions).

TCLP Sampling and Analysis

The Toxicity Characteristic Leachate Procedure (TCLP) is one of the most important analysis procedures that is available to characterize potentially HW. This method, SW-1311, simulates the conditions that a waste will encounter while in a landfill. This information is vitally important to determine whether or not a waste is a characteristic waste and what are the acceptable disposal methods for that solid waste.

What is the TCLP?

Specifically, the TCLP is a method used to determine whether a sample of waste exhibits a characteristic which will classify it as a hazardous waste. The TCLP procedure is outlined in 40 CFR 261, Subpart C. The actual method is outlined in SW-846. The analytes in the procedure were determined by USEPA to present a serious threat to health and the environment. On the list are 8 metals, 11 volatile organics, 15 semi-volatile organics, and 6 pesticides/herbicides (40 CFR 261.24). If the waste is found to contain a level above the regulatory limit on any one TCLP analyte, the waste is a characteristic HW.

The actual procedure simulates what, if any, of the 40 listed analytes will leach out of the material if it is placed into a landfill. The method requires at least 105 grams of solid material, or 2 liters plus 2 40 ml VOA vials if the waste is a nonorganic liquid. If the sample is a solid, the method requires an "extraction." This means that the sample is mixed with an acidic water solution similar to the rainwater trapped in a landfill. This extraction requires 18 hours to accomplish. Once the extraction is complete, the "extract" is filtered and then prepared for the various analytical procedures for metals, volatiles, semi-volatiles and pesticides.

What is the TCLP Used For? The TCLP is one of the four characteristic tests the EPA uses to determine if a waste is a hazardous waste via characteristic (the other three are ignitability,

corrosivity, and reactivity). Most DRMO and/or waste disposal companies require a complete analysis of all “unknown” wastes and known waste streams prior to acceptance. This information is also often required by local, state and federal regulations to be listed/included on all waste manifests, shipping documents and waste stream logs.

Why Request the TCLP? When a waste is “unknown” or requires a waste stream baseline or annual retest the TCLP should be requested. In a known waste stream it is vitally important to ensure that the waste has not changed. The TCLP information combined with the Major Components and the other three characteristics will allow proper characterization of a waste under RCRA.

When is the TCLP Not Applicable?

There are three reasons a sample may not be a candidate for the TCLP. One, the sample is an organic liquid; two the sample may contain a “listed waste”; or three, the sample has demonstrated a characteristic other than the TCLP.

As previously stated, the TCLP is used to determine if a material can be legally placed into a landfill by determining if it will leach any of the TCLP contaminants above the regulatory limit. Since landfilling of organic liquids is practically impossible under the Land Disposal Restrictions (40 CFR 268) the TCLP is not applicable for them.

Secondly, the TCLP is an “EXTRACTION” procedure. The laboratory cannot extract an organic liquid using an aqueous media. Method 1311 states that if a sample is “not compatible with the extraction fluid” it should be analyzed separately. What this means is that other methods should be used to determine if a sample is a hazardous waste. These alternatives will be discussed later.

If a sample contains a listed waste, as listed in 40 CFR 261 Subpart D, no further analysis is required under RCRA. The waste must be managed as a HW. If a MSDS is available, one may determine if the material contains a listed waste from that document. User knowledge may also be used to determine contents. Unfortunately, many disposal firms and certain DRMOs refuse to accept user knowledge for turn-in. Often times a complete laboratory analysis is still required regardless of how fool-proof waste stream documentation or user knowledge are. In this case, there are several methods available in the laboratory to determine if a sample contains a listed waste. They also will be discussed below.

A sample may exhibit one of the other characteristics such as ignitability, corrosivity, or reactivity. If this is the case, TCLP is not required as outlined in 40 CFR. The waste should be classified as hazardous, and managed as such.

Alternatives

As previously discussed, there are several alternatives to the TCLP. The primary reason for these alternative procedures is to determine the contents of the sample. Hopefully, from these

analysis results, the waste can clearly be defined as hazardous or not. It must be remembered that these results are TOTAL values and not "extract" concentrations. These total concentration results cannot be substituted for, converted to, nor interchanged with TCLP results. They should be used to determine whether or not a sample contains a listed waste or if the total values are lower than the TCLP regulatory limits. If this is the case, a TCLP is not required because an "extraction value" cannot be higher than a total concentration.

The alternative methods are listed in Table 3. These methods can be asked for in lieu of the TCLP when required. They will help classify your waste correctly according to the established list of hazardous constituents. The analysis methods used in the TCLP are the exact methods listed above except no extraction takes place prior to analysis. When the TCLP is not applicable, these methods are employed in the lab to identify and quantify wastes.

Paint and stripper wastes are special cases and a difficult analytical call. In most instances, they are NOT TCLP candidates due to organic liquid presence. However, if a large amount of the sample is solid (chips, sludge, paint solids, etc.) then the solid material may be extracted for TCLP. Generally, if a sample is greater than 25% solids a TCLP may be performed. If not, major components, SW-8240/8260, total metals content and ignitability should be requested. The laboratory can assist you in making these decisions.

Sampling for the TCLP

Sampling correctly for the TCLP is extremely important. **ANALYSES ARE ONLY AS REPRESENTATIVE AS THE SAMPLE SUBMITTED!** Whether you are sampling a drum, bowser, pit, separator, tank, or anything else, always submit a representative sample in sufficient quantity.

SW-846 specifies certain quantities required for the TCLP and other analyses. The laboratory CANNOT divert from the required amounts for analysis without compromising quality and validity of results. Therefore, the guidelines in Table 4 are the MINIMUMS. Remember, a little too much is always better than not enough. And remember that the TCLP is not appropriate for organic liquids.

It should be noted that the pesticides/herbicides analysis requires 1 liter of sample. Therefore, if a Full TCLP is requested then at least two additional liters of aqueous sample must be submitted. If two or more of the other parts of the TCLP analysis is required, then at least two liters are required.

Solid samples present undue sampling problems. Soil and sludge are fairly simple. Submit 250 grams of a representative sample of the matrix submitted. Unfortunately, other solids samples are not quite so simple.

Table 3. Alternative Analytical Methods

METHOD	CONTAMINANTS DETECTED	REASON TO USE
SW-8240	"F" Wastes, Solvents	Solvent screen, total values, listed wastes
SW-8260	Same as SW-8240	Same as SW-8240
SW-8020 (BTEX)	Non-halogenated solvents	Possible POL Contamination, total values, solvent screen
SW-8080	Chlorinated solvents	Screening
ASTM 5.02 "TX"	Halogen screen	Screening only, semi-quantitative
SW-7000 Series	"Total" TCLP Metals	POL wear metals, paint solvent metal content
Energy Recovery	Metals, solvents, PCB	POL organic liquids
Major Components	All above 1% by volume	Identify material

Table 4. Sufficient Quantities of Sample for the TCLP

LIQUID SAMPLES	REQUIRED QUANTITIES
TCLP-Full	2 liters and 2-40 ml VOA bottles (not phased aqueous) 3 liters and 2-40 ml VOA bottles (phased > 50%)
TCLP-no pesticides/herbicides	2 liters and 2-40 ml VOA bottles
TCLP-metals only	1 liter
Energy Recovery	1 liter
SW-8240, 8260, 8020	1 liter (if organic); 1 liter and 2-40 ml VOA bottles if aqueous
Major Components	500 ml
SOLID SAMPLES	
TCLP-Full	250 grams
TCLP-no pesticides/herbicides	250 grams
TCLP-metals only	250 grams
SW-8240, 8260, 8020	500 grams

NOTE: All samples must be in a glass bottle with a Teflon-lined lid and should be cooled to 4 degrees C.

Rags also require 250 grams of sample. However, since rags are not contaminated evenly, then a choice of the proper sample for analysis is critical. Remember that the rag itself is not a hazardous waste, the contaminant is the concern. If a good waste stream history is available, then the contaminant on the rags should be easily determined. If not, analysis may be required. Most rags are used in one of two areas, Corrosion Control or Aircraft Maintenance. Many known and listed hazardous wastes are used in these areas; this means that analysis of the rags is often required. When sampling, a worst case scenario is safest. Pick the worst contaminated rags. This will provide data on the most contaminated rags, thus providing adequate disposal information. Although this method will provide you with information on the most contaminated waste, often a representative sample will show that the entire collection of waste is not a hazardous waste under RCRA. Local, state and federal regulating bodies and disposal regulations should be consulted to determine the proper sampling method. Analysis on rags and other similar materials are requested similarly to liquid samples.

Filters also often require TCLP analysis. Filters from paint booths often are large in size and will not fit in a quart bottle. If this is the case, place at least 250 grams of material in a heavy duty plastic bag and send it in for analysis. As with rags, the filter itself is not a hazardous waste, the dust on the filter may cause the filter to fail the analysis. Consequently, extreme care should be taken to avoid shaking the dust from the filter. All dust, dirt, chips, and debris must be sent with the filter for analysis.

Oil, fuel, and gas filters are also unique; 250 grams of the filter element must be submitted for analysis. This may require you to have the outer metal case cut and remove the element for analysis. If the filter is a cartridge type, then the whole filter may be submitted.

Normally, the TCLP metals, volatiles, and semi-volatiles are of interest. Pesticides and herbicides are often not required by DRMOs and/or disposal companies.

If the full TCLP is required, then simply write it in on the "A" line of the AF Form 2751. If only the metals portion is required then simply mark TCLP-Metals. If the other characteristics are required, then check the hazardous/toxic waste box. This will provide you with Major Components, Ignitability, Corrosivity (pH), Reactivity, and TCLP-Metals.

Prior to submitting any sample to the laboratory, please remember to ask your DRMO or disposal contractor what analyses they will require for disposal. This information will ensure that the analyses you get are what you need for safe and legal disposal of the waste.

The Armstrong Laboratory Analytical Division recommends that all samples be collected in clear heavy-duty 1 liter glass bottles. A wide-mouth bottle is required for solid/sludge samples. These bottles can be obtained from all major scientific/medical suppliers.

All samples should be well packaged and shipped by the most expeditious method. Delaying shipment will only postpone analysis and possibly risk missing some holding times established by the EPA for volatile components.

Requirements for shipping samples to a laboratory for analysis are outlined in 40 CFR 261.4. In short, samples need not be managed as hazardous wastes, as long as the sample is properly packaged, marked, and labelled according to 49 CFR (Department of Transportation) and International Airline Transport Association (IATA) rules. These requirements are not much more restrictive than those listed in 40 CFR. They simply require the proper labeling prior to shipment. Contact your local shipper or the laboratory prior to shipment for guidance.

Selection of Analytical Procedures for Various Waste Streams

Table 5 lists several suggested analytical protocols for various waste streams. Note that listed sample amounts are the **MINIMUM**. When the full TCLP is requested, additional sample volume is helpful. All samples should be in glass containers. Liter bottles should be colorless and made from heavy duty glass with a Teflon-lined cap. VOA bottles must be new, clean, and have a Teflon septum. TCLP means the Toxicity Characteristic Leachate Procedure, SW-1311. HAZWAS means a waste characterization including ignitability, reactivity, corrosivity, and major components (when applicable). SW-8240/SW-8260 are analytical methods for volatile organics. SW-8260 is the method of choice due to increased separation of analytes and better sensitivity.

CONCLUSIONS

Analytical data are only as representative as the samples from whence they came. Multi-million dollar decisions are made based on data provided by BES to decision makers. Therefore, ensuring consistently high quality data must be a high priority.

Installation BES should have a thorough, well-documented program addressing waste sampling requirements. A complete waste analysis plan, including a waste stream characterization, should be the central document in their waste sampling and analysis program. The WAP and the hazardous waste stream inventory should be included as Sections 8 and 9 of the installation hazardous waste management plan.

Table 5. Hazardous Waste Analyses Request Recommendations

<u>MATRIX</u>	<u>MINIMUM SAMPLE VOLUME REQUIREMENTS</u>	<u>SUGGESTED ANALYSES</u>
	NON-PHASED LIQUIDS:	
Aqueous Samples	2 liters, 2 VOA bottles	TCLP, HAZWAS
Oils, Fuels, Lubes, (Petroleum Distillates)	1 liter	Energy Recovery
Paint Waste	1 liter	Major Components, Ignitability, Total Metals, SW-8240
Solvents (other than paint waste, i.e., chlorinateds, freons, etc.)	1 liter	Major Components, Ignitability, SW-8240, Total Metals
	PHASED LIQUIDS:	
Organic Liquid/Water	2 liters, 2 VOA bottles (aqueous fraction) and 1 liter of the organic fraction	TCLP, HAZWAS (aqueous fraction); HAZWAS (organic fraction)
Oils-Fuels-Lubes (Petroleum Distillates)	2 liters, 2 VOA bottles (aqueous fraction) and 1 liter of the organic fraction	TCLP, HAZWAS (aqueous fraction); Energy Recovery (organic fraction)
Paint Waste/Water	2 liters, 2 VOA bottles	TCLP, HAZWAS (aqueous fraction), HAZWAS (organic fraction)
	LIQUID/SOLIDS (>= 50% TOTAL VOLUME LIQUID):	
Aqueous/Solids	2 liters, 2 VOA bottles	TCLP, HAZWAS
Oil-Fuel/Solids (Top Layer)	1 liter	Energy Recovery (Note)
Paint Wastes/Solids (Top Layer)	1 liter	Major Components, Total Metals, Ignitability, SW-8240 or SW-8260
Solids	250 grams	TCLP, HAZWAS
	SOLIDS (<1% FREE LIQUIDS)	
Soils	250 grams	TCLP, HAZWAS
Sludges	250 grams	TCLP, HAZWAS
Filters, Rags, Adsorbents	250 grams	TCLP, HAZWAS
Blasting Media, Paint Chips, Residues	250 grams	TCLP, HAZWAS

NOTE: Analysis requirements depend upon disposal methods. These analytical procedures may be required if the waste is going to be separated and disposed of or recycled via different methods.

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APPENDIX A

40 CFR 261 SUBPART C-CHARACTERISTICS OF HAZARDOUS WASTE

261.20 General.

(a) A solid waste, as defined in § 261.2, which is not excluded from regulation as a hazardous waste under § 261.4(b), is a hazardous waste if it exhibits any of the characteristics identified in this subpart.

[Comment: § 262.11 of this chapter sets forth the generator's responsibility to determine whether his waste exhibits one or more of the characteristics identified in this subpart]

(b) A hazardous waste which is identified by a characteristic in this subpart is assigned every EPA Hazardous Waste Number that is applicable as set forth in this subpart. This number must be used in complying with the notification requirements of section 3010 of the Act and all applicable recordkeeping and reporting requirements under parts 262 through 265, 268, and 270 of this chapter.

(c) For purposes of this subpart, the Administrator will consider a sample obtained using any of the applicable sampling methods specified in appendix I to be a representative sample within the meaning of part 260 of this chapter.

[Comment: Since the appendix I sampling methods are not being formally adopted by the Administrator, a person who desires to employ an alternative sampling method is not required to demonstrate the equivalency of his method under the procedures set forth in §§ 260.20 and 260.21.]

261.21 Characteristic of ignitability.

(a) A solid waste exhibits the characteristic of ignitability if a representative sample of the waste has any of the following properties:

(1) It is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume and has flash point less than 60°C (140°F), as determined by a Pensky-Martens Closed Cup Tester, using the test method specified in ASTM Standard D-93-79 or D-93-80 (incorporated by reference, see § 260.11), or a Setaflash Closed Cup Tester, using the test method specified in ASTM Standard D-3278-78 (incorporated by reference, see § 260.11), or as determined by an equivalent test method approved by the Administrator under procedures set forth in §§ 260.20 and 260.21.

(2) It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard.

(3) It is an ignitable compressed gas as defined in 49 CFR 173.300 and as determined by the test methods described in that regulation or equivalent test methods approved by the Administrator under §§ 260.20 and 260.21.

(4) It is an oxidizer as defined in 49 CFR 173.151.

(b) A solid waste that exhibits the characteristic of ignitability has the EPA Hazardous Waste Number of D001.

261.22 Characteristic of corrosivity.

(a) A solid waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties:

(1) It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5, as determined by a pH meter using either an EPA test method or an equivalent test method approved by the Administrator under the procedures set forth in §§ 260.20 and 260.21. The EPA test

method for pH is specified as Method 5.2 in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods" (incorporated by reference, see § 260.11).

(2) It is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55°C (130°F) as determined by the test method specified in NACE (National Association of Corrosion Engineers) Standard TM-01-69 as standardized in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods" (incorporated by reference, see § 260.11) or an equivalent test method approved by the Administrator under the procedures set forth in §§ 260.20 and 260.21.

(b) A solid waste that exhibits the characteristic of corrosivity has the EPA Hazardous Waste Number of D002.

261.23 Characteristic of reactivity.

(a) A solid waste exhibits the characteristic of reactivity if a representative sample of the waste has any of the following properties:

- (1) It is normally unstable and readily undergoes violent change without detonating.
- (2) It reacts violently with water.
- (3) It forms potentially explosive mixtures with water.
- (4) When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.
- (5) It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.
- (6) It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.
- (7) It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.
- (8) It is a forbidden explosive as defined in 49 CFR 173.51, or a Class A explosive as defined in 49 CFR 173.53 or a Class B explosive as defined in 49 CFR 173.88.

(b) A solid waste that exhibits the characteristic of reactivity has the EPA Hazardous Waste Number of D003.

261.24 Toxicity characteristic.

(a) A solid waste exhibits the characteristic of toxicity if, using the test methods described in appendix II or equivalent methods approved by the Administrator under the procedures set forth in §§ 260.20 and 260.21, the extract from a representative sample of the waste contains any of the contaminants listed in table 1 at the concentration equal to or greater than the respective value given in that table. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering using the methodology outlined in appendix II, is considered to be the extract for the purpose of this section.

(b) A solid waste that exhibits the characteristic of toxicity has the EPA Hazardous Waste Number specified in Table I which corresponds to the toxic contaminant causing it to be hazardous.

Table 1-Maximum Concentration of Contaminants for the Toxicity Characteristic

EPA HW No.\1\	Contaminant	CAS No.\2\	Regulatory Level (mg/L)
D004	Arsenic	7440-38-2	5.0
D005	Barium	7440-39-3	100.0
D018	Benzene	71-43-2	0.5
D006	Cadmium	7440-43-9	1.0
D019	Carbon tetrachloride	56-23-5	0.5
D020	Chlordane	57-74-9	0.03
D021	Chlorobenzene	108-90-7	100.0
D022	Chloroform	67-66-3	6.0
D007	Chromium	7440-47-3	5.0
D023	o-Cresol	95-48-7	\4\ 200.0
D024	m-Cresol	108-39-4	\4\ 200.0
D025	p-Cresol	106-44-5	\4\ 200.0
D026	Cresol		\4\ 200.0
D016	2,4-D	94-75-7	10.0
D028	1,4-Dichlorobenzene	106-46-7	7.5
D027	1,2-Dichloroethane	107-06-2	0.5
D029	1,1-Dichloroethylene	75-35-4	0.7
D030	2,4-Dinitrotoluene	121-14-2	\3\ 0.13
D012	Endrin	72-20-8	0.02
D031	Heptachlor (and its epoxide)	76-44-8	0.008
D032	Hexachlorobenzene	118-74-1	\3\ 0.13
D033	Hexachlorobutadiene	87-68-3	0.5
D034	Hexachloroethane	67-72-1	3.0
D008	Lead	7439-92-1	5.0
D013	Lindane	58-89-9	0.4
D009	Mercury	7439-97-6	0.2
D014	Methoxychlor	72-43-5	10.0
D035	Methyl ethyl ketone	78-93-3	200.0
D036	Nitrobenzene	98-95-3	2.0
D037	Pentachlorophenol	87-86-5	100.0
D038	Pyridine	110-86-1	\3\ 5.0
D010	Selenium	7782-49-2	1.0
D011	Silver	7440-22-4	5.0
D039	Tetrachloroethylene	127-18-4	0.7
D015	Toxaphene	8001-35-2	0.5
D040	Trichloroethylene	79-01-6	0.5
D041	2,4,5-Trichlorophenol	95-95-4	400.0
D042	2,4,6-Trichlorophenol	88-06-2	2.0
D017	2,4,5-TP (Silvex)	93-72-1	1.0
D043	Vinyl chloride	75-01-4	0.2

\1\ Hazardous waste number. \2\ Chemical abstracts service number. \3\ Quantitation limit is greater than the calculated regulatory level. The quantitation limit therefore becomes the regulatory level.

\4\ If o-, m-, and p-Cresol concentrations cannot be differentiated, the total Cresol (D026) concentration is used. The regulatory level of total Cresol is 200 mg/l.

APPENDIX B

40 CFR 264.13, GENERAL WASTE ANALYSIS

40 CFR 264.13, General Waste Analysis.

(a)(1) Before an owner or operator treats, stores, or disposes of any hazardous wastes, or nonhazardous wastes if applicable under § 264.113(d), he must obtain a detailed chemical and physical analysis of a representative sample of the wastes. At a minimum, the analysis must contain all the information which must be known to treat, store, or dispose of the waste in accordance with this part and part 268 of this chapter.

(2) The analysis may include data developed under part 261 of this chapter, and existing published or documented data on the hazardous waste or on hazardous waste generated from similar processes.

[Comment: For example, the facility's records of analyses performed on the waste before the effective date of these regulations, or studies conducted on hazardous waste generated from processes similar to that which generated the waste to be managed at the facility, may be included in the data base required to comply with paragraph (a)(1) of this section. The owner or operator of an off-site facility may arrange for the generator of the hazardous waste to supply part of the information required by paragraph (a)(1) of this section, except as otherwise specified in 40 CFR 268.7 (b) and (c). If the generator does not supply the information, and the owner or operator chooses to accept a hazardous waste, the owner or operator is responsible for obtaining the information required to comply with this section.]

(3) The analysis must be repeated as necessary to ensure that it is accurate and up to date. At a minimum, the analysis must be repeated:

(i) When the owner or operator is notified, or has reason to believe, that the process or operation generating the hazardous wastes, or non-hazardous wastes if applicable under § 264.113(d), has changed; and

(ii) For off-site facilities, when the results of the inspection required in paragraph (a)(4) of this section indicate that the hazardous waste received at the facility does not match the waste designated on the accompanying manifest or shipping paper.

(4) The owner or operator of an off-site facility must inspect and, if necessary, analyze each hazardous waste movement received at the facility to determine whether it matches the identity of the waste specified on the accompanying manifest or shipping paper.

(b) The owner or operator must develop and follow a written waste analysis plan which describes the procedures which he will carry out to comply with paragraph (a) of this section. He must keep this plan at the facility. At a minimum, the plan must specify:

(1) The parameters for which each hazardous waste, or non-hazardous waste if applicable under § 264.113(d), will be analyzed and the rationale for the selection of these parameters (i.e., how analysis for these parameters will provide sufficient information on the waste's properties to comply with paragraph (a) of this section);

(2) The test methods which will be used to test for these parameters;

(3) The sampling method which will be used to obtain a representative sample of the waste to be analyzed. A representative sample may be obtained using either:

(i) One of the sampling methods described in appendix I of part 261 of this chapter; or

(ii) An equivalent sampling method.

[Comment: See § 260.21 of this chapter for related discussion.]

(4) The frequency with which the initial analysis of the waste will be reviewed or repeated to ensure that the analysis is accurate and up to date; and

(5) For off-site facilities, the waste analyses that hazardous waste generators have agreed to supply.

(6) Where applicable, the methods that will be used to meet the additional waste analysis requirements for specific waste management methods as specified in §§ 264.17, 264.314, 264.341, 264.1034(d), 264.1063(d), and 268.7 of this chapter.

(7) For surface impoundments exempted from land disposal restrictions under § 268.4(a), the procedures and schedules for:

(i) The sampling of impoundment contents;

(ii) The analysis of test data; and,

(iii) The annual removal of residues which are not delisted under § 260.22 of this chapter or which exhibit a characteristic of hazardous waste and either:

(A) Do not meet applicable treatment standards of part 268, subpart D; or

(B) Where no treatment standards have been established;

(1) Such residues are prohibited from land disposal under § 268.32 or RCRA section 3004(d); or

(2) Such residues are prohibited from land disposal under § 268.33(f).

(c) For off-site facilities, the waste analysis plan required in paragraph (b) of this section must also specify the procedures which will be used to inspect and, if necessary, analyze each movement of hazardous waste received at the facility to ensure that it matches the identity of the waste designated on the accompanying manifest or shipping paper. At a minimum, the plan must describe:

(1) The procedures which will be used to determine the identity of each movement of waste managed at the facility; and

(2) The sampling method which will be used to obtain a representative sample of the waste to be identified, if the identification method includes sampling.

(3) The procedures that the owner or operator of an off-site landfill receiving containerized hazardous waste will use to determine whether a hazardous waste generator or treater has added a biodegradable sorbent to the waste in the container.

[Comment: Part 270 of this chapter requires that the waste analysis plan be submitted with Part B of the permit application.]

APPENDIX C

40 CFR 268.7, WASTE ANALYSIS AND RECORDKEEPING

40 CFR 268.7, Waste Analysis and Recordkeeping.

(a) Except as specified in § 268.32 of this part, if a generator's waste is listed in 40 CFR part 261, subpart D, the generator must test his waste, or test an extract using the test method described in part 261, appendix II, or use knowledge of the waste, to determine if the waste is restricted from land disposal under this part. Except as specified in § 268.32 of this part, if a generator's waste exhibits one or more of the characteristics set out at 40 CFR part 261, subpart C, the generator must test an extract using the test method described in appendix IX of this part, or use knowledge of the waste, to determine if the waste is restricted from land disposal under this part.

(1) If a generator determines that he is managing a restricted waste under this part and the waste does not meet the applicable treatment standards set forth in subpart D of this part or exceeds the applicable prohibition levels set forth in § 268.32 or RCRA § 3004(d), with each shipment of waste the generator must notify the treatment or storage facility in writing of the appropriate treatment standards set forth in subpart D of this part and any applicable prohibition levels set forth in § 268.32 or RCRA § 3004(d). The notice must include the following information:

(i) EPA Hazardous Waste Number;

(ii) The corresponding treatment standards for wastes F001-F005, F039, and wastes prohibited pursuant to § 268.32 or RCRA section 3004(d). Treatment standards for all other restricted wastes must either be included, or be referenced by including on the notification the applicable wastewater (as defined in § 268.2(f)) or nonwastewater (as defined in § 268.2(d)) category, the applicable subdivisions made within a waste code based on waste-specific criteria (such as D003 reactive cyanides), and the CFR section(s) and paragraph(s) where the applicable treatment standard appears. Where the applicable treatment standards are expressed as specified technologies in § 268.42, the applicable five-letter treatment code found in Table 1 of § 268.42 (e.g., INCIN, WETOX) also must be listed on the notification.

(iii) The manifest number associated with the shipment of waste;

(iv) For hazardous debris, the contaminants subject to treatment as provided by §268.45(b) and the following statement: "This hazardous debris is subject to the alternative treatment standards of 40 CFR 268.45"; and

(v) Waste analysis data, where available.

(2) If a generator determines that he is managing a restricted waste under this Part, and determines that the waste can be land disposed without further treatment, with each shipment of waste he must submit, to the treatment, storage, or land disposal facility, a notice and a certification stating that the waste meets the applicable treatment standards set forth in subpart D of this part and the applicable prohibition levels set forth in §268.32 or RCRA section 3004(d). Generators of hazardous debris that is excluded from the definition of hazardous waste under §261.3(e)(2) of this chapter (i.e., debris that the Director has determined does not contain hazardous waste), however, are not subject to these notification and certification requirements.

(i) The notice must include the following information:

(A) EPA Hazardous Waste Number;

(B) The corresponding treatment standards for wastes F001-F005, F039, and wastes prohibited pursuant to § 268.32 or RCRA section 3004(d). Treatment standards for all other restricted wastes must either be included, or be referenced by including on the notification the

applicable wastewater (as defined in § 268.2(f)) or nonwastewater (as defined in § 268.2(d)) category, the applicable subdivisions made within a waste code based on waste-specific criteria (such as D003 reactive cyanides), and the CFR section(s) and paragraph(s) where the applicable treatment standard appears. Where the applicable treatment standards are expressed as specified technologies in § 268.42, the applicable five-letter treatment code found in Table 1 of § 268.42 (e.g., INCIN, WETOX) also must be listed on the notification.

(C) The manifest number associated with the shipment of waste;

(D) Waste analysis data, where available.

(ii) The certification must be signed by an authorized representative and must state the following:

I certify under penalty of law that I personally have examined and am familiar with the waste through analysis and testing or through knowledge of the waste to support this certification that the waste complies with the treatment standards specified in 40 CFR part 268 subpart D and all applicable prohibitions set forth in 40 CFR 268.32 or RCRA section 3004(d). I believe that the information I submitted is true, accurate and complete. I am aware that there are significant penalties for submitting a false certification, including the possibility of a fine and imprisonment.

(3) If a generator's waste is subject to an exemption from a prohibition on the type of land disposal method utilized for the waste (such as, but not limited to, a case-by-case extension under § 268.5, an exemption under § 268.6, or a nationwide capacity variance under subpart C), with each shipment of waste he must submit a notice to the facility receiving his waste stating that the waste is not prohibited from land disposal. The notice must include the following information:

(i) EPA Hazardous Waste Number;

(ii) The corresponding treatment standards for wastes F001-F005, F039, and wastes prohibited pursuant to § 268.32 or RCRA section 3004(d). Treatment standards for all other restricted wastes must either be included, or be referenced by including on the notification the applicable wastewater (as defined in § 268.2(f)) or nonwastewater (as defined in § 268.2(d)) category, the applicable subdivisions made within a waste code based on waste-specific criteria (such as D003 reactive cyanides), and the CFR section(s) and paragraph(s) where the applicable treatment standard appears. Where the applicable treatment standards are expressed as specified technologies in § 268.42, the applicable five-letter treatment code found in Table 1 of § 268.42 (e.g., INCIN, WETOX) also must be listed on the notification.

(iii) The manifest number associated with the shipment of waste;

(iv) Waste analysis data, where available;

(v) For hazardous debris, the contaminants subject to treatment as provided by §268.45(b) and the following statement: "This hazardous debris is subject to the alternative treatment standards of 40 CFR 268.45"; and

(vi) The date the waste is subject to the prohibitions.

(4) If a generator is managing prohibited waste in tanks, containers, or containment buildings regulated under 40 CFR 262.34, and is treating such waste in such tanks, containers, or containment buildings to meet applicable treatment standards under subpart D of this part, the generator must develop and follow a written waste analysis plan which describes the procedures the generator will carry out to comply with the treatment standards. (Generators treating hazardous debris under the alternative treatment standards of Table 1, §268.45, however, are not

subject to these waste analysis requirements.) The plan must be kept on site in the generator's records, and the following requirements must be met:

(i) The waste analysis plan must be based on a detailed chemical and physical analysis of a representative sample of the prohibited waste(s) being treated, and contain all information necessary to treat the waste(s) in accordance with the requirements of this part, including the selected testing frequency.

(ii) Such plan must be filed with the EPA Regional Administrator (or his designated representative) or State authorized to implement part 268 requirements a minimum of 30 days prior to the treatment activity, with delivery verified.

(iii) Wastes shipped off-site pursuant to this paragraph must comply with the notification requirements of § 268.7(a)(2).

(5) If a generator determines whether the waste is restricted based solely on his knowledge of the waste, all supporting data used to make this determination must be retained on-site in the generator's files. If a generator determines whether the waste is restricted based on testing this waste or an extract developed using the test method described in appendix I of this part, all waste analysis data must be retained on-site in the generator's files.

(6) If a generator determines that he is managing a restricted waste that is excluded from the definition of hazardous or solid waste or exempt from subtitle C regulation, under 40 CFR 261.2-261.6 subsequent to the point of generation, he must place a one-time notice stating such generation, subsequent exclusion from the definition of hazardous or solid waste or exemption from subtitle C regulation, and the disposition of the waste, in the facility's file.

(7) Generators must retain on-site a copy of all notices, certifications, demonstrations, waste analysis data, and other documentation produced pursuant to this section for at least five years from the date that the waste that is the subject of such documentation was last sent to on-site or off-site treatment, storage, or disposal. The five year record retention period is automatically extended during the course of any unresolved enforcement action regarding the regulated activity or as requested by the Administrator. The requirements of this paragraph apply to solid wastes even when the hazardous characteristic is removed prior to disposal, or when the waste is excluded from the definition of hazardous or solid waste under 40 CFR 261.2-261.6, or exempted from subtitle C regulation, subsequent to the point of generation.

(8) If a generator is managing a lab pack that contains wastes identified in appendix IV of this part and wishes to use the alternative treatment standard under § 268.42, with each shipment of waste the generator must submit a notice to the treatment facility in accordance with paragraph (a)(1) of this section. The generator must also comply with the requirements in paragraphs (a)(5) and (a)(6) of this section, and must submit the following certification, which must be signed by an authorized representative:

I certify under penalty of law that I personally have examined and am familiar with the waste and that the lab pack contains only the wastes specified in appendix IV to part 268 or solid wastes not subject to regulation under 40 CFR part 261. I am aware that there are significant penalties for submitting a false certification, including the possibility of fine or imprisonment.

(9) If a generator is managing a lab pack that contains organic wastes specified in appendix V of this part and wishes to use the alternate treatment standards under § 268.42, with each shipment of waste the generator must submit a notice to the treatment facility in accordance with paragraph (a)(1) of this section. The generator also must comply with the requirements in paragraphs (a)(5)

and (a)(6) of this section, and must submit the following certification which must be signed by an authorized representative:

I certify under penalty of law that I personally have examined and am familiar with the waste through analysis and testing or through knowledge of the waste and that the lab pack contains only organic waste specified in appendix V to part 268 or solid wastes not subject to regulation under 40 CFR part 261. I am aware that there are significant penalties for submitting a false certification, including the possibility of fine or imprisonment.

(10) Small quantity generators with tolling agreements pursuant to 40 CFR 262.20(e) must comply with the applicable notification and certification requirements of paragraph (a) of this section for the initial shipment of the waste subject to the agreement. Such generators must retain on-site a copy of the notification and certification, together with the tolling agreement, for at least three years after termination or expiration of the agreement. The three-year record retention period is automatically extended during the course of any unresolved enforcement action regarding the regulated activity or as requested by the Administrator.

(b) Treatment facilities must test their wastes according to the frequency specified in their waste analysis plans as required by § 264.13 or § 265.13. Such testing must be performed as provided in paragraphs (b)(1), (b)(2) and (b)(3) of this section.

(1) For wastes with treatment standards expressed as concentrations in the waste extract (Sec. 268.41), the owner or operator of the treatment facility must test the treatment residues, or an extract of such residues developed using the test method described in appendix I of this part, to assure that the treatment residues or extract meet the applicable treatment standards.

(2) For wastes that are prohibited under § 268.32 of this part or RCRA section 3004(d) but not subject to any treatment standards under subpart D of this part, the owner or operator of the treatment facility must test the treatment residues according to the generator testing requirements specified in § 268.32 to assure that the treatment residues comply with the applicable prohibitions.

(3) For wastes with treatment standards expressed as concentrations in the waste (Sec. 268.43), the owner or operator of the treatment facility must test the treatment residues (not an extract of such residues) to assure that the treatment residues meet the applicable treatment standards.

(4) A notice must be sent with each waste shipment to the land disposal facility which includes the following information, except that debris excluded from the definition of hazardous waste under §261.3(e) of this chapter (i.e., debris treated by an extraction or destruction technology provided by Table 1, §268.45, and debris that the Director has determined does not contain hazardous waste) is subject to the notification and certification requirements of paragraph (d) of this section rather than these notification requirements:

(i) EPA Hazardous Waste Number;

(ii) The corresponding treatment standards for wastes F001-F005, F039, and wastes prohibited pursuant to § 268.32 or RCRA section 3004(d). Treatment standards for all other restricted wastes must either be included, or be referenced by including on the notification the applicable wastewater (as defined in § 268.2(f)) or nonwastewater (as defined in § 268.2(d)) category, the applicable subdivisions made within a waste code based on waste-specific criteria (such as D003 reactive cyanides), and the CFR section(s) and paragraph(s) where the applicable treatment standard appears. Where the applicable treatment standards are expressed as specified technologies in § 268.42, the applicable five-letter treatment code found in Table 1 of § 268.42 (e.g., INCIN, WETOX) also must be included on the notification.

- (iii) The manifest number associated with the shipment of waste; and
- (iv) Waste analysis data, where available.

(5) The treatment facility must submit a certification with each shipment of waste or treatment residue of a restricted waste to the land disposal facility stating that the waste or treatment residue has been treated in compliance with the applicable performance standards specified in subpart D of this part and the applicable prohibitions set forth in §268.32 or RCRA section 3004(d). Debris excluded from the definition of hazardous waste under §261.3(e) of this chapter (i.e., debris treated by an extraction or destruction technology provided by Table 1, §268.45, and debris that the Director has determined does not contain hazardous waste), however, is subject to the notification and certification requirements of paragraph (d) of this section rather than the certification requirements of this paragraph (b)(5).

(i) For wastes with treatment standards expressed as concentrations in the waste extract or in the waste (Sec. 268.41 or § 268.43), or for wastes prohibited under § 268.32 of this part or RCRA section 3004(d) which are not subject to any treatment standards under subpart D of this part, the certification must be signed by an authorized representative and must state the following:

I certify under penalty of law that I have personally examined and am familiar with the treatment technology and operation of the treatment process used to support this certification and that, based on my inquiry of those individuals immediately responsible for obtaining this information, I believe that the treatment process has been operated and maintained properly so as to comply with the performance levels specified in 40 CFR part 268, subpart D, and all applicable prohibitions set forth in 40 CFR 268.32 or RCRA section 3004(d) without impermissible dilution of the prohibited waste. I am aware that there are significant penalties for submitting a false certification, including the possibility of fine and imprisonment.

(ii) For wastes with treatment standards expressed as technologies (Sec. 268.42), the certification must be signed by an authorized representative and must state the following:

I certify under penalty of law that the waste has been treated in accordance with the requirements of 40 CFR 268.42. I am aware that there are significant penalties for submitting a false certification, including the possibility of fine and imprisonment.

(iii) For wastes with treatment standards expressed as concentrations in the waste pursuant to § 268.43, if compliance with the treatment standards in subpart D of this part is based in part or in whole on the analytical detection limit alternative specified in § 268.43(c), the certification also must state the following:

I certify under penalty of law that I have personally examined and am familiar with the treatment technology and operation of the treatment process used to support this certification and that, based on my inquiry of those individuals immediately responsible for obtaining this information, I believe that the nonwastewater organic constituents have been treated by incineration in units operated in accordance with 40 CFR part 264, subpart O) or 40 CFR part 265, subpart O, or by combustion in fuel substitution units operating in accordance with applicable technical requirements, and I have been unable to detect the nonwastewater organic constituents despite having used best good faith efforts to analyze for such constituents. I am aware that there are significant penalties for submitting a false certification, including the possibility of fine and imprisonment.

(6) If the waste or treatment residue will be further managed at a different treatment or storage facility, the treatment, storage or disposal facility sending the waste or treatment residue off-site must comply with the notice and certification requirements applicable to generators under this section.

(7) Where the wastes are recyclable materials used in a manner constituting disposal subject to the provisions of § 266.20(b) regarding treatment standards and prohibition levels, the owner or operator of a treatment facility (i.e., the recycler) is not required to notify the receiving facility, pursuant to paragraph (b)(4) of this section. With each shipment of such wastes the owner or operator of the recycling facility must submit a certification described in paragraph (b)(5) of this section, and a notice which includes the information listed in paragraph (b)(4) of this section (except the manifest number) to the Regional Administrator, or his delegated representative. The recycling facility also must keep records of the name and location of each entity receiving the hazardous waste-derived product.

(c) Except where the owner or operator is disposing of any waste that is a recyclable material used in a manner constituting disposal pursuant to 40 CFR 266.20(b), the owner or operator of any land disposal facility disposing any waste subject to restrictions under this part must:

(1) Have copies of the notice and certifications specified in paragraph (a) or (b) of this section, and the certification specified in § 268.8 if applicable.

(2) Test the waste, or an extract of the waste or treatment residue developed using the test method described in appendix I of this part or using any methods required by generators under § 268.32 of this part, to assure that the wastes or treatment residues are in compliance with the applicable treatment standards set forth in subpart D of this part and all applicable prohibitions set forth in § 268.32 of this part or in RCRA section 3004(d). Such testing must be performed according to the frequency specified in the facility's waste analysis plan as required by § 264.13 or § 265.13.

(d) Generators or treaters who first claim that hazardous debris is excluded from the definition of hazardous waste under § 261.3(e) of this chapter (i.e., debris treated by an extraction or destruction technology provided by Table 1, §268.45, and debris that the Director has determined does not contain hazardous waste) are subject to the following notification and certification requirements:

(1) A one-time notification must be submitted to the Director or authorized State including the following information:

(i) The name and address of the Subtitle D facility receiving the treated debris;

(ii) A description of the hazardous debris as initially generated, including the applicable EPA Hazardous Waste Number(s); and

(iii) For debris excluded under §261.3(e)(1) of this chapter, the technology from Table 1, §268.45, used to treat the debris.

(2) The notification must be updated if the debris is shipped to a different facility, and, for debris excluded under §261.2(e)(1) of this chapter, if a different type of debris is treated or if a different technology is used to treat the debris.

(3) For debris excluded under §261.3(e)(1) of this chapter, the owner or operator of the treatment facility must document and certify compliance with the treatment standards of Table 1, §268.45, as follows:

(i) Records must be kept of all inspections, evaluations, and analyses of treated debris that are made to determine compliance with the treatment standards;

(ii) Records must be kept of any data or information the treater obtains during treatment of the debris that identifies key operating parameters of the treatment unit; and

(iii) For each shipment of treated debris, a certification of compliance with the treatment standards must be signed by an authorized representative and placed in the facility's files. The certification must state the following: "I certify under penalty of law that the debris has been treated in accordance with the requirements of 40 CFR 268.45. I am aware that there are significant penalties for making a false certification, including the possibility of fine and imprisonment."

APPENDIX D

**40 CFR 279, STANDARDS FOR THE MANAGEMENT OF USED OIL
(EXCERPTS)**

40 CFR 279 - Standards for the Management of Used Oil (Excerpts)

s§ 279.10 Applicability.

This section identifies those materials which are subject to regulation as used oil under this part. This section also identifies some materials that are not subject to regulation as used oil under this part, and indicates whether these materials may be subject to regulation as hazardous waste under parts 260 through 266, 268, 270, and 124 of this chapter.

(a) Used oil. EPA presumes that used oil is to be recycled unless a used oil handler disposes of used oil, or sends used oil for disposal. Except as provided in §279.11, the regulations of this part apply to used oil, and to materials identified in this section as being subject to regulation as used oil, whether or not the used oil or material exhibits any characteristics of hazardous waste identified in subpart C of part 261 of this chapter.

(b) Mixtures of used oil and hazardous waste-(1) Listed hazardous waste. (i) Mixtures of used oil and hazardous waste that is listed in subpart D of part 261 of this chapter are subject to regulation as hazardous waste under parts 260 through 266, 268, 270, and 124 of this chapter, rather than as used oil under this part.

(ii) Rebuttable presumption for used oil. Used oil containing more than 1,000 ppm total halogens is presumed to be a hazardous waste because it has been mixed with halogenated hazardous waste listed in subpart D of part 261 of this chapter. Persons may rebut this presumption by demonstrating that the used oil does not contain hazardous waste (for example, by using an analytical method from SW-846, Edition III, to show that the used oil does not contain significant concentrations of halogenated hazardous constituents listed in appendix VIII of part 261 of this chapter). EPA Publication SW-846, Third Edition, is available for the cost of \$110.00 from the Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954, (202) 783-3238 (document number 955-001-00000-1).

(A) The rebuttable presumption does not apply to metalworking oils/fluids containing chlorinated paraffins, if they are processed, through a tolling arrangement as described in §279.24(c), to reclaim metalworking oils/fluids. The presumption does apply to metalworking oils/fluids if such oils/fluids are recycled in any other manner, or disposed.

(B) The rebuttable presumption does not apply to used oils contaminated with chlorofluorocarbons (CFCs) removed from refrigeration units where the CFCs are destined for reclamation. The rebuttable presumption does apply to used oils contaminated with CFCs that have been mixed with used oil from sources other than refrigeration units.

(2) Characteristic hazardous waste. Mixtures of used oil and hazardous waste that exhibits a hazardous waste characteristic identified in subpart C of part 261 of this chapter are subject to:

(i) Except as provided in paragraph (b)(2)(iii) of this section, regulation as hazardous waste under parts 260 through 266, 268, 270, and 124 of this chapter rather than as used oil under this part, if the resultant mixture exhibits any characteristics of hazardous waste identified in subpart C of part 261 of this chapter; or

(ii) Regulation as used oil under this part, if the resultant mixture does not exhibit any characteristics of hazardous waste identified under subpart C of part 261 of this chapter.

(iii) Regulation as used oil under this part, if the mixture is of used oil and a waste which is hazardous solely because it exhibits the characteristic of ignitability and is not listed in subpart D of part 261 of this chapter (e.g., mineral spirits), provided that the mixture does not exhibit the characteristic of ignitability under §261.21 of this chapter.

(3) Conditionally exempt small quantity generator hazardous waste. Mixtures of used oil and conditionally exempt small quantity generator hazardous waste regulated under §261.5 of this chapter are subject to regulation as used oil under this part.

(c) Mixtures of used oil with non-hazardous solid wastes. Mixtures of used oil and non-hazardous solid waste are subject to regulation as used oil under this part.

(d) Mixtures of used oil with products. (1) Except as provided in paragraph (d)(2) of this section, mixtures of used oil and fuels or other products are subject to regulation as used oil under this part.

(2) Mixtures of used oil and diesel fuel mixed on-site by the generator of the used oil for use in the generator's own vehicles are not subject to this part once the used oil and diesel fuel have been mixed. Prior to mixing, the used oil is subject to the requirements of subpart C of this part.

(e) Materials derived from used oil. (1) Materials that are reclaimed from used oil that are used beneficially and are not burned for energy recovery or used in a manner constituting disposal (e.g., re-refined lubricants) are:

(i) Not used oil and thus are not subject to this part, and

(ii) Not solid wastes and are thus not subject to the hazardous waste regulations of parts 260 through 266, 268, 270, and 124 of this chapter as provided in §261.3(c)(2)(i) of this chapter.

(2) Materials produced from used oil that are burned for energy recovery (e.g., used oil fuels) are subject to regulation as used oil under this part.

(3) Except as provided in paragraph (e)(4) of this section, materials derived from used oil that are disposed of or used in a manner constituting disposal are:

(i) Not used oil and thus are not subject to this Part, and

(ii) Are solid wastes and thus are subject to the hazardous waste regulations of parts 260 through 266, 268, 270, and 124 of this chapter if the materials are identified as hazardous waste.

(4) Re-refining distillation bottoms that are used as feedstock to manufacture asphalt products are:

(i) Not subject to this part at this time, and

(ii) Not subject to the hazardous waste regulations of parts 260 through 266, 268, 270, and 124 of this chapter at this time.

(f) Wastewater. Wastewater, the discharge of which is subject to regulation under either section 402 or section 307(b) of the Clean Water Act (including wastewaters at facilities which have eliminated the discharge of wastewater), contaminated with de minimis quantities of used oil are not subject to the requirements of this part. For purposes of this paragraph, "de minimis" quantities of used oils are defined as small spills, leaks, or drippings from pumps, machinery, pipes, and other similar equipment during normal operations or small amounts of oil lost to the wastewater treatment system during washing or draining operations. This exception will not apply if the used oil is discarded as a result of abnormal manufacturing operations resulting in substantial leaks, spills, or other releases, or to used oil recovered from wastewaters.

(g) Used oil introduced into crude oil or natural gas pipelines. Used oil that is placed directly into a crude oil or natural gas pipeline is subject to the management standards of this part only prior to the point of introduction to the pipeline. Once the used oil is introduced to the pipeline, the material is exempt from the requirements of this part.

(h) Used oil on vessels. Used oil produced on vessels from normal shipboard operations is not subject to this part until it is transported ashore.

(i) PCB contaminated used oil. PCB-containing used oil regulated under part 761 of this chapter is exempt from regulation under this part.

§ 279.11 Used oil specifications.

Used oil burned for energy recovery, and any fuel produced from used oil by processing, blending, or other treatment, is subject to regulation under this part unless it is shown not to exceed any of the allowable levels of the constituents and properties in the specification shown in Table 1. Once used oil that is to be burned for energy recovery has been shown not to exceed any specification and the person making that showing complies with §§279.72, 279.73, and 279.74(b), the used oil is no longer subject to this part.

Table 1 - Used Oil Not exceeding Any Specification Level Is Not Subject to This Part When Burned for Energy Recovery\1\

Constituent/ property	Allowable level
Arsenic	5 ppm maximum
Cadmium	2 ppm maximum
Chromium	10 ppm maximum
Lead	100 ppm maximum
Flash point	100 °F minimum
Total halogens	4,000 ppm maximum \2\

{Footnote}\1\ The specification does not apply to mixtures of used oil and hazardous waste that continue to be regulated as hazardous waste (see §279.10(b)).

{Footnote}\2\ Used oil containing more than 1,000 ppm total halogens is presumed to be a hazardous waste under the rebuttable presumption provided under §279.10(b)(1). Such used oil is subject to subpart H of part 266 of this chapter rather than this part when burned for energy recovery unless the presumption of mixing can be successfully rebutted.

§ 279.72 On-specification used oil fuel.

(a) Analysis of used oil fuel. A generator, transporter, processor/re-refiner, or burner may determine that used oil that is to be burned for energy recovery meets the fuel specifications of §279.11 by performing analyses or obtaining copies of analyses or other information documenting that the used oil fuel meets the specifications. Such used oil that is to be burned for energy recovery is not subject to further regulation under this part.

(b) Record retention. A generator, transporter, processor/re-refiner, or burner who first claims that used oil that is to be burned for energy recovery meets the specifications for used oil fuel under §279.11, must keep copies of analyses of the used oil (or other information used to make the determination) for three years.

APPENDIX E

SAMPLE INSTALLATION WASTE ANALYSIS PLAN

Section H of the sample WAP is intended to be analytical schemes for each individual waste stream on the installation. These could be written in a generic fashion, as many waste streams will be nearly the same in composition. We have provided several generic analytical schemes in the example WAP. Each installation will need to write additional schemes and delete schemes not required. Also, analyses other than those required by RCRA may be required by some states. Each installation needs to be aware of specific state requirements and ensure that these are addressed as required in the waste analysis plan.

Section I of the attached plan is intended to be a copy of the hazardous waste stream inventory maintained by the installation. The completeness of the WAP will be in many respects dependent on the information in the hazardous waste stream inventory. This inventory should contain such elements as the work area name, squadron, office symbol, building number, waste stream type and number, quantities (i.e., pounds, gallons, each, etc.), type of treatment as applicable, and disposal methods. Other information should be included as desired.

It is expected that each installation will make modifications to the plan to make it better fit the situation on the particular installation.

The sample WAP has a section (J) for listing known profiles of various waste streams on the installation. You should let this section of the plan "write itself," as you accumulate analyses of various waste streams. Using this method, you should generate a nearly complete set of profiles within 12 to 18 months. The profile (DRMS Form 1930) should contain the information from the hazardous waste stream inventory plus the proper DOT shipping name, EPA waste numbers, how contained (i.e., barrels, tanks, etc.), physical state (liquid, solid, gas) of the waste, and the hazardous properties of the waste (toxic, ignitable, etc.).

WASTE ANALYSIS PLAN

999th WING ANY AFB, ANYSTATE

This hazardous waste analysis plan (WAP) standardizes the procedures used for the analysis of wastes generated within the 999th Wing. It contains procedures for waste stream evaluation and analysis, including a series of analytical schemes for the selection of hazardous waste (HW) analyses. The schemes are designed for the efficient analysis of various categories of wastes. The rationale for the selection of parameters that are outlined in the schemes is based on the material safety data sheet (MSDS) of the process chemicals, previous process analytical data, and knowledge of the process. This plan covers the HW streams that the 999th Wing generates. The 999th Wing is a large and diversified organization where process changes are ongoing. Additional analytical schemes for new types of waste will be included in future revisions of this plan as necessary. The analytical schemes outlined in this plan are intended for use only by laboratories using U.S. Environmental Protection Agency (EPA) approved analytical methodologies.

This plan is maintained by 999th Medical Group Bioenvironmental Engineering Services (BES).

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A. GENERAL INFORMATION:

1. Requirements:

a. General:

(1) The objective of this WAP is to describe the procedures that will be undertaken to obtain sufficient waste information to operate a hazardous waste management facility in accordance with the hazardous waste management rules and policy applicable to the 999th Wing. The WAP establishes the hazardous waste sampling and analysis procedures that will be routinely conducted as a requirement of the Resource Conservation and Recovery Act (RCRA) HW management program.

(2) A minimal WAP must contain information on analytical parameters and methods, and sampling methods and frequency. However, such a plan would be largely useless for other than minimal regulatory compliance. Such elements as analysis location, sample documentation, QA/QC procedures, procedures for evaluating new waste streams, and procedures for evaluating a waste itself are needed to make the WAP a useful management tool. This WAP endeavors to answer the following four questions:

(a) What are the specific wastes or types of wastes that will be managed within each process?

(b) What are the waste-associated properties that are of concern in ensuring safe and effective management (e.g., kcal/g (Btu) content, % water)?

(c) What are the specific waste parameters that have to be quantified in order to satisfy the data needs?

(d) How will the necessary data be obtained, including what sampling and analysis procedures, and what attendant quality control/quality assurance procedures are to be carried out by the permittee?"

b. In RCRA, the Congress of the United States outlined, in Sec. 1003(b), the following: "NATIONAL POLICY.-The Congress hereby declares it to be the national policy of the United States that, wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste that is nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment."

c. Generators of solid waste must determine if the generated solid waste is regulated as a hazardous waste (40 CFR 262.11). 40 CFR 264.13 requires that the operator of a treatment, storage, and disposal (TSD) facility have a WAP, to include a "detailed chemical and physical analysis of a representative sample of the waste." If the waste is deemed potentially hazardous and is not a listed HW, testing to determine if the wastes meet any of the characteristics listed in 40 CFR 261 is required. In addition, the generator is required to determine if the waste is land

disposal restricted (40 CFR 268.7). Several requirements are outlined in 40 CFR 264.13. These are summarized within the following paragraphs:

(1) The waste analysis may contain data generated from sources other than laboratory analyses.

(2) The analysis must be repeated as necessary to ensure accuracy and timeliness. It must be repeated when process or operational changes alter the waste characteristics, or when waste received from off-site does not match the designation on the accompanying manifest. No specific time periods are listed for repeating analysis, either in 40 CFR or in the OEBGD. In general, analyses will be repeated annually or when required to reconfirm characterization of individual waste streams. Otherwise, only significant process changes or changes in materials should necessitate resampling of a waste stream.

(3) This WAP specifies:

(a) The parameters for which each waste will be analyzed and the rationale for the selection of these parameters (i.e., how analysis for these parameters will provide sufficient information on the waste's properties to comply with 264.13(a)).

(b) The test methods which will be used to test for these parameters.

(c) The sampling method which will be used to obtain a representative sample of the waste to be analyzed. A representative sample may be obtained using either:

(1) One of the sampling methods in appendix I of 40 CFR 261.

(2) An equivalent sampling method.

(d) The frequency with which the initial analysis of the waste will be reviewed or repeated to ensure that the analysis is accurate and up to date.

(e) For off-site facilities, the waste analyses that HW generators have agreed to supply.

(f) Where applicable, the methods that will be used to meet the additional waste analysis requirements for specific waste management methods specified elsewhere in 40 CFR 264 and 268.7.

(g) For off-site facilities, the procedures which will be used to inspect and, if necessary, analyze each movement of HW received at the facility to ensure that it matches the identity of the waste designated on the accompanying manifest or shipping paper. Minimally:

(1) The procedures which will be used to determine the identity of each movement of waste managed at the facility; and

(2) The sampling method which will be used to obtain a representative sample of the waste to be identified, if the identification method includes sampling.

(4) The specific rules governing surface impoundments do not apply to the 999th Wing.

d. OEBGD Requirements: In general, the guidance in the OEBGD tracks closely with the RCRA rules contained in 40 CFR. However, the OEBGD is far less detailed than the 40 CFR rules. The following paragraphs contain several of the requirements listed in the OEBGD which may differ slightly from the 40 CFR rules.

(1) Generators of hazardous waste (for the purposes of the OEBGD, the installation or DoD activity generating the waste is considered the generator) must "identify and characterize the wastes generated at their site using their knowledge of the materials and processes which generated the waste or through laboratory analysis of the waste. A Hazardous Waste Profile Sheet [HWPS, DRMS Form 1930] will be used to identify each hazardous waste stream." The OEBGD requires that the installation maintain a file of profile sheets for "each waste stream handled." These should be filed in the Environmental Flight office as well as in section J of the WAP.

(2) In addition to the 40 CFR requirements, the OEBGD requires that the WAP include "procedures for characterization and verification testing of both on-site and off-site hazardous waste." Currently, 999th Wing is using Armstrong Laboratory and its contractors as analytical laboratories. The generator is also required to "conduct periodic verification testing" of wastes in storage in an installation's Hazardous Waste Storage Area (HWSA).

(3) Waste Analysis and Characterization Records, i.e., profile sheets and sampling documentation and results, must be retained "until three years after closure." Closure here indicates discontinuation of the use of a specific HWSA on an installation.

2. Responsibilities:

a. HW Generators will notify the Environmental Coordinator and BES when waste streams require initial sampling or recharacterization.

c. BES will arrange for sampling and analysis of waste streams on the installation.

d. Transportation Packing and Crating will package samples for shipment, and assist Environmental officials with complying with applicable Department of Transportation (DOT) requirements.

3. Installation Specific Issues: [Discuss any issues specific to your installation in this section. In particular, the California installations will have many additional requirements from the California Code of Regulations (CCR). Overseas bases may have additional requirements listed in the Final Governing Standards for their host country laws and regulations.]

4. Update of the Waste Analysis Plan: BES is the OPR for updating the WAP. Update of the WAP is required:

- a. When the sampling frequency changes (typically due to changes in the volume of waste generated).
- b. When analytical requirements change (typically due to changes in the processes generating the waste, or to changes in disposal contracts).
- c. When regulatory requirements change (i.e., EPA changes its waste code designations, etc.).
- d. When disposal methods change (such as the changes caused by the land disposal restrictions).

5. How to Request Sampling/Analytical Services: Generators should contact BES at 555-9998 or 9999 to arrange for any needed sampling and analysis of an individual waste stream. Allow 2 to 4 months lead time to allow BES to collect and coordinate analysis of the sample(s) with the analytical laboratory.

B. WASTE EVALUATION

1. Definition of a Waste: Before a waste analysis can be performed, the basic question of if the material in question is a waste, and furthermore a solid waste, must be answered. If the answer to any of the following questions is yes, the material is a waste.

- a. Is the material no longer useful for its intended purpose because it is dirty, out of specification, or a spill residue?
- b. Is it an unintended or unusable byproduct?
- c. Does the base intend to discard the material for eventual treatment, storage, recycling, or disposal?
- d. Is it produced by cleanup at a previously uncontrolled waste site?

2. Definition of a Solid Waste: The RCRA definition of a solid waste is as follows: "...any garbage, refuse, sludge, from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act as amended (86 Stat. 880), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923)."

3. Definition of a Hazardous Waste: A solid waste is a hazardous waste if:

- a. It is not excluded from regulation as a hazardous waste and;
- b. It meets one of the characteristics listed in 40 CFR 261 Subpart C (ignitability, reactivity, corrosivity, or exceeds a limiting value in the Toxicity Characteristic Leachate Procedure (TCLP)).
- c. It is a listed hazardous waste in 40 CFR 261 Subpart D.
- d. It is a mixture of a solid waste and a hazardous waste listed in Subpart D that is listed solely because it meets one of the characteristics listed in Subpart C, unless the resultant mixture does not meet one of the Subpart C characteristics.
- e. It is a mixture of solid waste and one or more hazardous wastes listed in subpart D and has not been excluded from regulation. Several specific regulatory exclusions are listed in 40 CFR 261.3.

4. Evaluation Procedures: The following paragraphs will describe the analytical process by which all waste streams will be analyzed.

a. The TCLP, EPA Method 1311, as outlined in Appendix II of 40 CFR 261, will be performed on nearly all waste streams (with the exception of organic liquids). The TCLP extracts will only be analyzed for those analytes identified in the specific analytical schemes, not the complete list of contaminants identified in Table 1 of 40 CFR 261.24. The other tests listed in 40 CFR 261.21-23 (reactivity, corrosivity, and ignitability) will be utilized as necessary. Table 2 in Section C of this WAP lists recommendations for analyses for several general waste stream types. POL wastes will be analyzed for energy recovery.

b. The analyte concentrations obtained will be compared to their respective maximum concentration of contaminants for the toxicity characteristic limits identified in Table 1, 40 CFR 261.24.

c. If the analytes detected in the TCLP extract equal or exceed their respective limits in Table 1, the waste stream will be considered hazardous and no further analyses will be performed.

d. Waste streams that will be land disposed will be analyzed using the TCLP, EPA Method 1311, as outlined in Appendix II, 40 CFR 261. The TCLP extract will be analyzed by the appropriate EPA Methods for only those analytes identified in the analytical schemes. The analyte concentrations will be compared to their respective land disposal restrictions (LDRs) outlined in 40 CFR 268. If any of the analyte concentrations equal or exceed their respective LDRs, then the waste stream cannot be land disposed without treatment. If all analytes detected are below their respective LDRs, then the waste stream can be land disposed without treatment.

C. ANALYTICAL PROCEDURES

1. Listing of Analytical Methods and Sources:

a. Before a sample is submitted for laboratory analysis, a determination if the waste is a listed hazardous waste will be performed. If the waste is a listed hazardous waste, then analysis is not required. The waste must be handled as a hazardous waste.

b. The Toxicity Characteristic Leachate Procedure (TCLP) is one of the most important analysis procedures that is available to characterize potentially HW. This method, SW-1311, simulates the conditions that a waste will encounter while in a landfill. This information is vitally important to determine whether or not a waste is a characteristic waste and what are the acceptable disposal methods for that solid waste.

(1) Specifically, the TCLP is a method used to determine whether a sample of waste exhibits a characteristic which will classify it as a hazardous waste. The TCLP procedure is outlined in 40 CFR 261, Subpart C. The actual method is outlined in SW-846. The analytes in the procedure were determined by USEPA to present a serious threat to health and the environment; 8 metals, 11 volatile organics, 15 semi-volatile organics, and 6 pesticides/herbicides are on the list (40 CFR 261.24). If the waste is found to contain a level above the regulatory limit on any one TCLP analyte, the waste is a characteristic HW.

(2) The actual procedure simulates what, if any, of the 40 listed analytes will leach out of the material if it is placed into a landfill. The method requires at least 105 grams of solid material and 2 liters if the waste is a non-organic liquid. If the sample is a solid the method requires an "extraction." This means that the sample is mixed with an acidic water solution similar to the rainwater trapped in a landfill. This extraction requires 18 hours to accomplish. Once the extraction is complete, the "extract" is filtered and then prepared for the various analytical procedures for metals, volatiles, semi-volatiles and pesticides.

(3) The TCLP is one of the four characteristic tests the EPA uses to determine if a waste is a hazardous waste via characteristic (the other three are ignitability, corrosivity, and reactivity). Most DRMO and/or waste disposal companies require a complete analysis of all "unknown" wastes and known waste streams prior to acceptance. This information is also often required by local, state and federal regulations to be listed/included on all waste manifests, shipping documents and waste stream logs.

(4) When a waste is "unknown" or requires a waste stream baseline or annual retest the TCLP should be requested. In a known waste stream it is vitally important to ensure that the waste has not changed. The TCLP information combined with the Major Components and the other three characteristics will allow proper characterization of a waste under RCRA.

(5) There are three reasons a sample may not be a candidate for the TCLP. One, the sample is an organic liquid; two, the sample may contain a "listed waste"; or three, the sample has demonstrated a characteristic other than the TCLP.

(a) As previously stated, the TCLP is used to determine if a material can be legally placed into a landfill by determining if it will leach any of the TCLP contaminants above the regulatory limit. Since landfilling of organic liquids is practically impossible under the Land Disposal Restrictions (40 CFR 268) the TCLP is not applicable for them.

(b) Secondly, the TCLP is an "EXTRACTION" procedure. The laboratory cannot extract an organic liquid using an aqueous media. Method 1311 states that if a sample is "not compatible with the extraction fluid" it should be analyzed separately. What this means is that other methods should be used to determine if a sample is a hazardous waste. These alternatives will be discussed later.

(c) If a sample contains a listed waste, as listed in 40 CFR 261 Subpart D, no further analysis is required under RCRA. The waste must be managed as a HW. If a MSDS is available, one may determine if the material contains a listed waste from that document. User knowledge may also be used to determine contents. Unfortunately, many disposal firms and certain DRMOs refuse to accept user knowledge for turn-in. Often times a complete laboratory analysis is still required regardless of how fool-proof waste stream documentation or user knowledge are. In this case, there are several methods available in the laboratory to determine if a sample contains a listed waste. They also will be discussed later.

(d) A sample may exhibit one of the other characteristics such as ignitability, corrosivity, or reactivity. If this is the case, TCLP is not required as outline in 40 CFR. The waste should be classified as hazardous, and managed as such.

(6) Alternatives:

(a) As previously discussed, there are several alternatives to the TCLP. The primary reason for these alternative procedures is to determine the contents of the sample. Hopefully, from these analysis results, the waste can clearly be defined as hazardous or not. It must be remembered that these results are TOTAL values and not "extract" concentrations. These total concentration results cannot be substituted for, converted to, nor interchanged with TCLP results. They should be used to determine whether or not a sample contains a listed waste or if the total values are lower than the TCLP regulatory limits. If this is the case, a TCLP is not required because an "extraction value" cannot be higher than a total concentration.

(b) The alternative methods are listed in Table 1. These methods can be asked for in lieu of the TCLP when required. They will help classify your waste correctly according to the established list of hazardous constituents. The analysis methods used in the TCLP are the exact methods listed above except no extraction takes place prior to analysis. When the TCLP is not applicable, these methods are employed in the lab to identify and quantify wastes.

(c) Paint and stripper wastes are special cases and a difficult analytical call. In most instances, they are NOT TCLP candidates due to organic liquid presence. However, if a large amount of the sample is solid (chips, sludge, paint solids, etc.) then the solid material may be

extracted for TCLP. Generally, if a sample is greater than 25% solids a TCLP may be performed. If not, major components, SW-8240/8260, total metals content and ignitability should be requested. The laboratory can assist you in making these decisions.

Table 1. Alternative Analytical Methods

METHOD	CONTAMINANTS DETECTED	REASON TO USE
SW-8240	"F" Wastes, Solvents	Solvent screen, total values, listed wastes
SW-8260	Same as SW-8240	Same as SW-8240
SW-8020 (BTEX)	Non-halogenated solvents	Possible POL Contamination, total values, solvent screen
SW-8080	Chlorinated solvents	Screening
ASTM 5.02 "TX"	Halogen screen	Screening only, semi-quantitative
SW-7000 Series	"Total" TCLP Metals	POL wear metals, paint solvent metal content
Energy Recovery	Metals, solvents, PCB	POL organic liquids
Major Components	All above 1% by volume	Identify material

(7) Selection of Analytical Procedures for Various Waste Streams: Table 2 lists several suggested analytical protocols for various waste streams. Note that listed sample amounts are the **MINIMUM**. When the full TCLP is requested additional sample volume is helpful. All samples should be in glass containers. Liter bottles should be colorless and made from heavy duty glass with a Teflon-lined cap. VOA bottles must be new, clean, and have a Teflon septum. TCLP means the Toxicity Characteristic Leachate Procedure, SW-1311. HAZWAS means a waste characterization including ignitability, reactivity, corrosivity, and major components (when applicable). SW-8240 and SW-8260 are analytical methods for volatile organics. SW-8260 is the method of choice due to increased separation of analytes and better sensitivity.

(8) Other Analytical Procedures:

(a) Energy Recovery: This set of tests typically ran on organic wastes (usually waste POL products), to determine their suitability for incineration. Samples are analyzed for major components, flash point, total metals, and PCBs.

(b) Major components will determine, to 1% by volume, the makeup of a waste sample, including the aqueous/organic percentage, if applicable.

(c) Solvent Scans (SW-8240 and SW-8260): These are used to determine if some wastes, mainly aqueous and paint wastes, contain chlorinated and/or other organic solvents which may subject them to the 40 CFR 268 Land Disposal Restrictions (LDRs).

Table 2. Hazardous Waste Analyses Request Recommendations

<u>MATRIX</u>	<u>MINIMUM SAMPLE VOLUME REQUIREMENTS</u>	<u>SUGGESTED ANALYSES</u>
	NON-PHASED LIQUIDS:	
Aqueous Samples	2 liters, 2 VOA bottles	TCLP, HAZWAS
Oils, Fuels, Lubes, (Petroleum Distillates)	1 liter	Energy Recovery
Paint Waste	1 liter	Major Components, Ignitability, Total Metals, SW-8240
Solvents (other than paint waste, i.e., chlorinateds, freons, etc.)	1 liter	Major Components, Ignitability, SW-8240, Total Metals
	PHASED LIQUIDS:	
Organic Liquid/Water	2 liters, 2 VOA bottles (aqueous fraction) and 1 liter of the organic fraction	TCLP, HAZWAS (aqueous fraction); HAZWAS (organic fraction)
Oils-Fuels-Lubes (Petroleum Distillates)	2 liters, 2 VOA bottles (aqueous fraction) and 1 liter of the organic fraction	TCLP, HAZWAS (aqueous fraction); Energy Recovery (organic fraction)
Paint Waste/Water	2 liters, 2 VOA bottles	TCLP, HAZWAS (aqueous fraction), HAZWAS (organic fraction)
	LIQUID/SOLIDS (>= 50% TOTAL VOLUME LIQUID):	
Aqueous/Solids	2 liters, 2 VOA bottles	TCLP, HAZWAS
Oil-Fuel/Solids (Top Layer)	1 liter	Energy Recovery (Note)
Paint Wastes/Solids (Top Layer)	1 liter	Major Components, Total Metals, Ignitability, SW-8240 or SW-8260
Solids	250 grams	TCLP, HAZWAS
	SOLIDS (<1% FREE LIQUIDS)	
Soils	250 grams	TCLP, HAZWAS
Sludges	250 grams	TCLP, HAZWAS
Filters, Rags, Adsorbents	250 grams	TCLP, HAZWAS
Blasting Media, Paint Chips, Residues	250 grams	TCLP, HAZWAS

NOTE: Analysis requirements depend upon disposal methods. These analytical procedures may be required if the waste is going to be separated and disposed of or recycled via different methods.

2. Justification for Analytical Laboratory Selection: [Each installation will have to put in a paragraph or two discussing its decision on which analytical laboratory(ies) it will use for waste stream analyses.]

D. WASTE STREAM SAMPLING PROCEDURES:

1. Waste Containerization:

a. Whenever economical and practical, all waste should be isolated when containerized, and not commingled. The potential problems created by commingling include the risk of mixing incompatible materials, increased difficulty in obtaining a representative sample, increased time and cost of analyses, reduction of resale value of the waste, and additional difficulty and increase in cost for disposal. Currently, used oils, with the exception of PCB containing oils, which are mixed prior to recycling, are one exception to segregation.

b. Empty containers: 40 CFR 261.7, "Residues of hazardous waste in empty containers," is reproduced below for your information. Basically, a container is considered empty when the material it contained has been removed completely using normal removal/emptying techniques. Notably, compressed gas/aerosol containers are considered empty when their pressure has reached atmospheric and the contents have been drained. This allows spray paint cans to be disposed of as normal trash once they are "emptied." One gallon cans of paint can be thrown out if no more than three percent of the volume remains (i.e., about 4 ounces). Five gallon cans could have as much as 20 ounces inside and be considered "empty." Paint or other material in cans will be allowed to dry and harden before disposal as normal solid waste (i.e., in the dumpster).

"40 CFR 261.7, Residues of hazardous waste in empty containers.

(a)(1) Any hazardous waste remaining in either (i) an empty container or (ii) an inner liner removed from an empty container, as defined in paragraph (b) of this section, is not subject to regulation under parts 261 through 265, or part 268, 270 or 124 of this chapter or to the notification requirements of section 3010 of RCRA.

(2) Any hazardous waste in either (i) a container that is not empty or (ii) an inner liner removed from a container that is not empty, as defined in paragraph (b) of this section, is subject to regulation under parts 261 through 265, and parts 268, 270 and 124 of this chapter and to the notification requirements of section 3010 of RCRA.

(b)(1) A container or an inner liner removed from a container that has held any hazardous waste, except a waste that is a compressed gas or that is identified as an acute hazardous waste listed in §§ 261.31, 261.32, or 261.33(e) of this chapter is empty if:

(i) All wastes have been removed that can be removed using the practices commonly employed to remove materials from that type of container, e.g., pouring, pumping, and aspirating, and

(ii) No more than 2.5 centimeters (one inch) of residue remain on the bottom of the container or inner liner, or

(iii)(A) No more than 3 percent by weight of the total capacity of the container remains in the container or inner liner if the container is less than or equal to 110 gallons in size, or

(B) No more than 0.3 percent by weight of the total capacity of the container remains in the container or inner liner if the container is greater than 110 gallons in size.

(2) A container that has held a hazardous waste that is a compressed gas is empty when the pressure in the container approaches atmospheric.

(3) A container or an inner liner removed from a container that has held an acute hazardous waste listed in §§ 261.31, 261.32, or 261.33(e) is empty if:

(i) The container or inner liner has been triple rinsed using a solvent capable of removing the commercial chemical product or manufacturing chemical intermediate;

(ii) The container or inner liner has been cleaned by another method that has been shown in the scientific literature, or by tests conducted by the generator, to achieve equivalent removal; or

(iii) In the case of a container, the inner liner that prevented contact of the commercial chemical product or manufacturing chemical intermediate with the container, has been removed."

2. Frequency of Waste Stream Sampling: Waste streams are to be sampled whenever a new waste stream is generated or whenever there have been changes in the process generating a waste stream. Usually, all waste streams will be characterized annually.

3. Specific Waste Stream Sampling Methods: It is imperative that a representative sample be obtained for analysis. All waste samples collected are grab samples which are collected by COLIWASA or other appropriate methods outlined in 40 CFR 261 and SW-846. USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9360.4-07, "Compendium of ERT [Environmental Response Team] Sampling Procedures," will be used to guide specific sampling events.

4. Sample Control: All waste streams sampled will be labeled and assigned a sample control number. A chain of custody form will be filled out for each waste stream sample if required. The chain of custody form will have the sampler's name, sample number, analysis requested, and all additional information requested on the form. For sample validity, each time the sample is relinquished, the receiving person must sign for custody of the sample until it reaches the lab. When the sample is taken to the laboratory, the chain of custody form will be signed by the person who takes physical custody of the sample (usually the receiving laboratory technician). When analytical results are received, the sample log book will reflect the date the sample was received. BES will then take the required steps to accurately characterize and profile the waste.

5. Sampling Procedures:

a. General:

(1) Definition of objectives: Briefly state the reasons the sample or set of samples is being collected. State regulatory or permit requirements if there are any. Previous trends at a particular sampling location may be the driving force for sampling. Thoroughly explain and logically support your reasoning.

(2) Design of sampling protocols: SW-846 contains a brief but thorough discussion of sample collection and preservation procedures. A thorough sampling protocol contains many elements, such as the exact sampling location, sampling equipment needed, sampling frequency,

analytes of interest, sampling procedures, randomization technique utilized (as applicable), points of contact at the sampling site, etc. The sampling protocol should be sufficient for completion of the sampling event without needing another information source.

(3) Several suggested field sampling protocols are in the literature. Because of widely varying possible waste sampling requirements, outlining a generally applicable protocol is difficult. Barcelona (1988) presented the outline of a generalized sampling protocol which is applicable to the majority of waste sampling plans. He listed seven points, each with a number of subelements. Table 3 is a reproduction of Table 1 from his paper.

Table 3. Outline of a Generalized Sampling Protocol (After Barcelona, 1988)

MAIN POINT (PROGRAM PURPOSE)	SUBELEMENTS
Analytes of interest	Primary and secondary chemical constituents and criteria for representativeness
Locations	Site, depth, and frequency
Sampling points	Design, construction, and performance evaluation
Sample collection	Mechanism, materials, and methodology
Sample handling	Preservation, filtration, and field control samples
Field determinations	Unstable species and additional sampling variables
Sample storage and transport	Preservation of sample integrity

b. Sampling for the TCLP:

(1) Sampling correctly for the TCLP is extremely important. **ANALYSES ARE ONLY AS REPRESENTATIVE AS THE SAMPLE SUBMITTED!** Whether you are sampling a drum, bowser, pit, separator, tank, or anything else, always submit a representative sample in sufficient quantity.

(2) SW-846 specifies certain quantities required for the TCLP and other analyses. The laboratory CANNOT divert from the required amounts for analysis without compromising quality and validity of results. Therefore, the guidelines in Table 4 are the MINIMUMS. Remember, a little too much is always better than not enough.

(3) It should be noted that the pesticides/herbicides analysis requires 1 liter of sample. Therefore, if a Full TCLP is requested then at least two additional liters of aqueous sample must be submitted. If two or more of the other parts of the TCLP analysis is required, then at least two liters are required.

(4) Solid samples present some unique sampling problems. Soil and sludge are fairly simple. Submit 250 grams of a representative sample of the matrix submitted. Unfortunately, other solids samples are not quite so simple.

Table 4. Sufficient Quantities of Sample for the TCLP

LIQUID SAMPLES	REQUIRED QUANTITIES
TCLP-Full	2 liters and 2-40 ml VOA bottles (not phased aqueous) 3 liters and 2-40 ml VOA bottles (phased > 50%)
TCLP-no pesticides/herbicides	2 liters and 2-40 ml VOA bottles
TCLP-metals only	1 liter
Energy Recovery	1 liter
SW-8240, 8260, 8020	1 liter (if organic); 1 liter and 2-40 ml VOA bottles if aqueous
Major Components	500 ml
SOLID SAMPLES	
TCLP-Full	250 grams
TCLP-no pesticides/herbicides	250 grams
TCLP-metals only	250 grams
SW-8240, 8260, 8020	500 grams

NOTE: All samples must be in a glass bottle with a Teflon-lined lid and should be cooled to 4 degrees C.

(5) Rags also require 250 grams of sample. However, since rags are not contaminated evenly, then a choice of the proper sample for analysis is critical. Remember that the rag itself is not a hazardous waste, the contaminant is the concern. If a good waste stream history is available, then the contaminant on the rags should be easily determined. If not, analysis may be required. Most rags are used in one of two areas, Corrosion Control or Aircraft Maintenance. Many known and listed hazardous wastes are used in these areas; this means that analysis of the rags is often required. When sampling, a worst case scenario is safest. Pick the worst contaminated rags. This will provide data on the most contaminated rags, thus providing adequate disposal information. Although this method will provide you with information on the most contaminated waste, often a representative sample will show that the entire collection of waste is not a hazardous waste under RCRA. Local, state and federal regulating bodies and disposal regulations should be consulted to determine the proper sampling method. Analysis on rags and other similar materials are requested similarly to liquid samples.

(6) Filters also often require TCLP analysis. Filters from paint booths often are large in size and will not fit in a quart bottle. If this is the case, place at least 250 grams of material in a heavy duty plastic bag and send it in for analysis. As with rags, the filter itself is not a hazardous waste, the dust on the filter may cause the filter to fail the analysis. Consequently, extreme care should be taken to avoid shaking the dust from the filter. All dust, dirt, chips, and debris must be sent with the filter for analysis.

(7) Oil, fuel, and gas filters are also unique; 250 grams of the filter element must be submitted for analysis. This may require you to have the outer metal case cut and remove the element for analysis. If the filter is a cartridge type, then the whole filter may be submitted.

(8) Normally, the TCLP metals, volatiles, and semi-volatiles are of interest. Pesticides and herbicides are often not required by DRMOs and/or disposal companies.

c. Filling Out Sample Submittal/Analyses Request Paperwork:

(1) If the full TCLP is required, then simply write it in on the 'A' line of the AF Form 2751. If only the metals portion is required then simply mark TCLP-Metals. If the other characteristics are required, then check the hazardous/toxic waste box. This will provide you with Major Components, Ignitability, Corrosivity (pH), Reactivity, and TCLP-Metals. For Energy Recovery analyses, simply write this on the 'A' line of the 2751.

(2) Prior to submitting any sample to the laboratory, please remember to ask your DRMO or disposal contractor what analyses they will require for disposal. This will ensure that the analyses you get are what you need for safe and legal disposal of the waste.

(3) When filling out the AF Form 2751, give the analytical personnel as much information as possible. For example:

Did an organic vapor detector "smell" anything?
Did any person smell anything?
Where did the waste come from?
What was the pH (if aqueous in nature)?
Was the drum pressurized?

The more information you provide helps the laboratory personnel to perform a more focused set of analyses.

d. Sample Submittal:

(1) All samples will be collected in clear heavy-duty 1 liter glass bottles (except, of course, for aqueous VOA samples). A wide-mouth bottle is required for solid/sludge samples. These bottles can be obtained from all major scientific/ medical suppliers.

(2) All samples will be well packaged and shipped by the most expeditious method. Delaying shipment postpone analyses and risks missing holding times established by the EPA for volatile components.

e. Requirements for shipping samples to a laboratory for analysis are outlined in 40 CFR 261.4. In short, samples need not be managed as hazardous wastes, as long as the sample is properly packaged, marked, and labelled according to 49 CFR (Department of Transportation) and International Airline Transport Association (IATA) rules. These requirements are not much

more restrictive than those listed in 40 CFR. They simply require the proper labelling prior to shipment. Transportation Squadron Packing and Crating will provide current guidance on packaging and shipping waste characterization samples. 40 CFR 261.4(d) is reproduced below:

“d) Samples. (1) Except as provided in paragraph (d)(2) of this section, a sample of solid waste or a sample of water, soil, or air, which is collected for the sole purpose of testing to determine its characteristics or composition, is not subject to any requirements of this part or parts 262 through 268 or part 270 or part 124 of this chapter or to the notification requirements of section 3010 of RCRA, when:

- (i) The sample is being transported to a laboratory for the purpose of testing; or
- (ii) The sample is being transported back to the sample collector after testing; or
- (iii) The sample is being stored by the sample collector before transport to a laboratory for testing; or

- (iv) The sample is being stored in a laboratory before testing; or

- (v) The sample is being stored in a laboratory after testing but before it is returned to the sample collector; or

- (vi) The sample is being stored temporarily in the laboratory after testing for a specific purpose (for example, until conclusion of a court case or enforcement action where further testing of the sample may be necessary).

(2) In order to qualify for the exemption in paragraphs (d)(1)(i) and (ii) of this section, a sample collector shipping samples to a laboratory and a laboratory returning samples to a sample collector must:

- (i) Comply with U.S. Department of Transportation (DOT), U.S. Postal Service (USPS), or any other applicable shipping requirements; or

- (ii) Comply with the following requirements if the sample collector determines that DOT, USPS, or other shipping requirements do not apply to the shipment of the sample:

- (A) Assure that the following information accompanies the sample:

- (1) The sample collector's name, mailing address, and telephone number;

- (2) The laboratory's name, mailing address, and telephone number;

- (3) The quantity of the sample;

- (4) The date of shipment; and

- (5) A description of the sample.

- (B) Package the sample so that it does not leak, spill, or vaporize from its packaging.

(3) This exemption does not apply if the laboratory determines that the waste is hazardous but the laboratory is no longer meeting any of the conditions stated in paragraph (d)(1) of this section.”

6. Health and Safety Protocols: Procedures outlined in the USEPA Publication “Standard Operating Safety Guides” will be used during waste stream sampling operations.

E. QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC):

1. Sampling QA/QC:

a. Only laboratories using EPA approved analytical methodologies will be used for hazardous waste analyses. The laboratories that the Wing currently uses are the Analytical Division of the USAF Armstrong Laboratory at Brooks AFB, Texas, and civilian laboratories contracted by Armstrong Laboratory for hazardous waste sample analysis.

b. The quality assurance and quality control procedures used by Armstrong Laboratory and its contractors are not included as part of this plan. Required QA/QC information can be obtained from Armstrong Laboratory/OEA and/or its contractors.

c. There are statistical techniques for obtaining accurate and precise samples that are relatively simple and easy to implement. Sampling accuracy is usually achieved by one form of statistically valid random sampling. Precision is manipulated by varying the number of and volume or weight of the samples taken.

b. In order to lower sampling and analytical costs, composite samples are often used. A composite sample is obtained by collecting a number of random samples from a waste, combining the individual samples into a single sample, and analyzing the single sample for the parameters/constituents of concern.

2. Documentation Requirements (Field and Office):

a. Field Documentation:

(1) The importance of complete field documentation cannot be overstressed. The resources invested in sampling and analysis are wasted if the accompanying data/documentation is incomplete or inaccurate. A field logbook is an important part of the document chain, and will be used to record all waste sampling events. All entries will be signed and dated. All members of the field sampling team will use this logbook, which will be kept as a permanent record.

(2) Field logbooks are intended to provide sufficient data and observations to enable sampling team members to reconstruct events that occurred during projects and to refresh the memory of the field personnel. The field logbook entries will be factual, detailed, and objective.

(3) The documentation in the field logbook for each sample will include, minimally, the following:

(a) Location of the sampling point.

(b) Type of process producing the waste.

(c) Physical form of the waste (solid, liquid, semi-solid, sludge, etc.)

(d) Number and volume of sample(s) taken.

(e) Purpose of the sampling event.

(f) Description of the sampling methodology, with critical attention as to the statistical validity and representativeness of the sample(s).

(g) Name of sampling personnel, date and time of sampling event.

b. Office Documentation: Completed DRMS Forms 1930 and sampling and analytical forms and results are maintained in the applicable BES casefile, in a file in the Environmental Coordinator's office, and as section J of this WAP. All other sampling and analytical records will be maintained in BES, Environmental Flight, and HW generator files per their respective files maintenance and disposition plans.

3. Data Validation and Interpretation Procedures: The Bioenvironmental Engineer is the individual designated to interpret analytical data and apply the data to waste management operations.

a. Documentation Completeness: Determine that detailed and complete records exist to adequately define the sampling event. As a minimum, the records should be such that a competently trained technician from another installation could fully recreate the sampling event.

b. Sample Validity: The Chief or NCOIC of BES should review the records to identify gaps or problems with the records that might affect sample validity. There are many issues which could invalidate samples, such as incorrect collection, preservation, or shipping of samples.

c. Data Correlation: Ask yourself if the data make sense in light of field observations, knowledge about the process, etc. Laboratories don't make very many mistakes (i.e., getting samples mixed up), but if they go undetected, the end result could be catastrophic.

d. Anomalous Field Test Data: Review all analytical data, both field and laboratory generated. Note inconsistencies in the data and their impact on sample validity. Document and explain as necessary.

e. Field Data Validation: Review all data derived from field analyses (either in situ or from field laboratories) and determine if there are problems with the data that may invalidate or call into question the results of the sampling event.

4. Chain of custody procedures will be used when samples must meet legal or permit requirements. A sample chain of custody form is included in the AFOEHL Sampling Guide.

a. A sample is under custody if one or more of the following criteria are met:

- (1) The sample is in the sampler's possession.
- (2) It is in the sampler's view after being in possession.
- (3) It was in the sampler's possession and then was locked up to prevent tampering.
- (4) It is in a designated secure area.

b. Field Custody Procedures: Only enough of the sample should be collected to provide a good representation of the medium being sampled. To the extent possible, the quantity and types of samples and the sample locations are determined before the actual field work. As few people as possible should handle the samples. Field samplers are personally responsible for the care and custody of the samples collected by their sampling teams until the samples are transferred or dispatched properly.

5. Representative sampling methods are listed in Appendix I to 40 CFR 261. Containerized liquid wastes are sampled with the containerized liquid waste sampler, or COLIWASA. Liquid wastes in pits, ponds, lagoons, and similar reservoirs are sampled with a pond sampler. Non-liquid wastes are typically sampled using augers, coring tools, shovels, etc. SW-846 contains detailed instructions on statistically valid sampling methodologies. 40 CFR 261, Appendix I-Representative Sampling Methods, is listed below. The RCRA rules list these procedures to use to meet the requirements for representative sampling.

"The methods and equipment used for sampling waste materials will vary with the form and consistency of the waste materials to be sampled. Samples collected using the sampling protocols listed below, for sampling waste with properties similar to the indicated materials, will be considered by the Agency to be representative of the waste.

Extremely viscous liquid--ASTM Standard D140-70 Crushed or powdered material--ASTM Standard D346-75 Soil or rock-like material--ASTM Standard D420-69 Soil-like material--ASTM Standard D1452-65

Fly Ash-like material--ASTM Standard D2234-76 [ASTM Standards are available from ASTM, 1916 Race St., Philadelphia, PA 19103]

Containerized liquid wastes--"COLIWASA" described in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods,"¹ U.S. Environmental Protection Agency, Office of Solid Waste, Washington, D.C. 20460. [Copies may be obtained from Solid Waste Information, U.S. Environmental Protection Agency, 26 W. St. Clair St., Cincinnati, Ohio 45268]

{Footnote}¹ These methods are also described in "Samplers and Sampling Procedures for Hazardous Waste Streams," EPA 600/2-80-018, January 1980.

Liquid waste in pits, ponds, lagoons, and similar reservoirs.--"Pond Sampler" described in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods."

F. SAMPLING METHODS AND EQUIPMENT

1. Listing of Equipment and Resources Required: [List the equipment and supplies BES will need to carry out this WAP. Items such as containers, COLIWASAs, dippers, gloves and other PPE, respirators, etc., should be listed.]

2. References to Generalized Sampling Methods:

<u>Type of Waste</u>	<u>Method</u>	<u>Equipment</u>
Extremely Viscous Liquid	SW-846	COLIWASA, Thief, or Tubing
Crushed or Powdered Material	ASTM E725-86 SW-846	Scoop, Shovel, Trier, or Tubing
Soil or Rock-like Material	ASTM E725-86 SW-846	Auger, Scoop, Shovel, Trier, or Tubing
Soil-like Material	ASTM E725-86 SW-846	Auger, Scoop, Shovel, Trier, or Tubing
Fly-ash-like Material	ASTM E725-86 SW-846	Auger, Scoop, Shovel, Trier, or Tubing
Containerized Liquids	SW-846	COLIWASA, Tubing, Weighted Bottle, Dipper Sampler, or Drum Thief

G. REFERENCES AND PERTINENT LITERATURE

- AF Occupational and Environmental Health Laboratory (AFOEHL). 1989. Recommended Sampling Procedures. March 1989, (now) Armstrong Laboratory Occupational and Environmental Health Directorate, Brooks AFB, TX.
- AFR 19-7, "Environmental Pollution Monitoring," 19 April 1985.
- AFR 19-11, "Hazardous Waste Management and Minimization," 14 July 1989.
- AFR 91-9, "Water Pollution Control Facilities," 1 December 1989.
- American Society for Testing and Materials (ASTM). 1987. "D4687-87, Standard Guide for General Planning of Waste Sampling."
- ASTM E725-86, "Standard Method of Sampling Granular Carriers and Granular Pesticides."
- APHA/AWWA/WEF. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition.
- Barcelona, M. J. 1988. "Overview of the Sampling Process." In Principles of Environmental Sampling, 1988, L. H. Keith, editor. American Chemical Society, Washington, D. C. 20036. 458 pp.
- Department of Defense Overseas Environmental Task Force. 1992. Overseas Environmental Baseline Guidance Document, October 1992.
- HQ USAF/CEV Letter, "Air Force Policy on Used Oil and Used Oil Filter Disposal," 18 June 1992.
- HQ USAF/CV Letter, "Air Force Hazardous Waste Management Policy," 6 June 1991.
- Hazardous and Solid Waste Amendments of 1984, Public Law 98-616, 98 Stat. 3221.
- Keith, L. H. 1988. Principles of Environmental Sampling. American Chemical Society, Washington, D. C. 20036. 458pp.
- McClellan AFB Hazardous Waste Management Plan 19-1, 1 Jun 92, 2852 Air Base Group, McClellan AFB, CA 95652.
- Resource Conservation and Recovery Act (Solid Waste Disposal Act), Public Law 94-580, 42 USCA 6901 et seq.
- Solid Waste Disposal Act Amendments of 1980, Public Law 96-482, 94 Stat. 2334.

Title 40, Code of Federal Regulations (40 CFR), Subchapter I, Solid Wastes.

Title 49, Code of Federal Regulations (49 CFR), Hazardous Materials.

United States Environmental Protection Agency (USEPA). 1980. Samplers and Sampling Procedures for Hazardous Waste Streams, EPA-600/2-80-018, Office of Solid Waste, USEPA, Washington, D.C. 20460.

USEPA. 1984. Waste Analysis Plans. EPA/530-SW-012. Office of Solid Waste, USEPA, Washington, D.C. 20460.

USEPA. 1986. Test Methods for Evaluating Solid Waste-- Physical/Chemical Methods, SW-846, USEPA, Washington, D.C. 20460.

USEPA. 1991. Compendium of ERT Waste Sampling Procedures, OSWER Directive 9360.4-07, EPA/540/P-91/008. USEPA, Washington, D.C. 20460.

USEPA. 1992. Standard Operating Safety Guides. Publication 9285.1-03, Office of Emergency and Remedial Response, Washington, D. C., 20460, 182pp.

Wentz, C. A. 1989. Hazardous Waste Management. 461pp. McGraw-Hill Inc., New York, NY.

H. ANALYTICAL SCHEMES

List analytical schemes for each individual waste stream on the installation in this section. These should be written much like a checklist. A few generic examples are in the following table.

WASTE STREAM	SUGGESTED ANALYSES	COLLECTION REQUIREMENTS
1. Waste Oils	Energy Recovery	1 liter
2. Waste Paint/Paint Thinners	Major Components, Ignitability, Total Metals, SW-8240	2 liters
3. Solid Materials	TCLP, HAZWAS	250 grams
4. Waste Solvents	Major Components, SW-8240, Ignitability, Total Metals	1 liter
5. Used Absorbent Materials	TCLP, Major Components, Ignitability	250 grams
6. Used Antifreeze	HAZWAS, Total Metals	1 liter
7. Unknown - Aqueous Matrix	TCLP, HAZWAS	1 liter
8. Unknown - Organic Matrix	Major Components, Ignitability, SW-8240, Total Metals	1 liter
9. Unknown - Solid Matrix	TCLP, HAZWAS	250 grams
10. Battery Electrolyte	TCLP Metals, Corrosivity, Reactivity	1 liter
11. Waste Fuels	Energy Recovery	1 liter
12. Sludges	TCLP, HAZWAS	250 grams

I. HAZARDOUS WASTE STREAM INVENTORY

List: (1) Waste generator/facility; (2) Location of generator; (3) Waste stream number; and (4) Waste characterization/description.

This is an ideal database or spreadsheet application. Include any other information you think is appropriate.

J. WASTE STREAM PROFILES

This section should include a copy of the DRMS Form 1930, Hazardous Waste Profile Sheet, for each waste stream on the installation. Attach sampling and analytical paperwork to the DRMS Form 1930.

APPENDIX F

OSWER DIRECTIVE 9360.4-07, JANUARY 1991

COMPENDIUM OF ERT WASTE SAMPLING PROCEDURES

COMPENDIUM OF ERT WASTE SAMPLING PROCEDURES

Sampling Equipment Decontamination

Drum Sampling

Tank Sampling

Chip, Wipe, and Sweep Sampling

Waste Pile Sampling

Interim Final

Environmental Response Team
Emergency Response Division

Office of Emergency and Remedial Response
U.S. Environmental Protection Agency
Washington, DC 20460

Notice

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

The policies and procedures established in this document are intended solely for the guidance of government personnel, for use in the Superfund Removal Program. They are not intended, and cannot be relied upon, to create any rights, substantive or procedural, enforceable by any party in litigation with the United States. The Agency reserves the right to act at variance with these policies and procedures and to change them at any time without public notice.

Depending on circumstances and needs, it may not be possible or appropriate to follow these procedures exactly in all situations due to site conditions, equipment limitations, and limitations of the standard procedures. Whenever these procedures cannot be followed as written, they may be used as general guidance with any and all modifications fully documented in either QA Plans, Sampling Plans, or final reports of results.

Each Standard Operating Procedure in this compendium contains a discussion on quality assurance/quality control (QA/QC). For more information on QA/QC objectives and requirements, refer to the *Quality Assurance/Quality Control Guidance for Removal Activities*, OSWER directive 9360.4-01, EPA/540/G-90/004.

Questions, comments, and recommendations are welcomed regarding the Compendium of ERT Waste Sampling Procedures. Send remarks to:

Mr. William A. Coakley
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Raritan Depot - Building 18, MS-101
2890 Woodbridge Avenue
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For additional copies of the Compendium of ERT Waste Sampling Procedures, please contact:

National Technical Information Service (NTIS)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600

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1.0 SAMPLING EQUIPMENT DECONTAMINATION: SOP #2006

1.1 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes methods used for preventing or reducing cross-contamination, and provides general guidelines for sampling equipment decontamination procedures at a hazardous waste site. Preventing or minimizing cross-contamination in sampled media and in samples is important for preventing the introduction of error into sampling results and for protecting the health and safety of site personnel.

Removing or neutralizing contaminants that have accumulated on sampling equipment ensures protection of personnel from permeating substances, reduces or eliminates transfer of contaminants to clean areas, prevents the mixing of incompatible substances, and minimizes the likelihood of sample cross-contamination.

1.2 METHOD SUMMARY

Contaminants can be physically removed from equipment, or deactivated by sterilization or disinfection. Gross contamination of equipment requires physical decontamination, including abrasive and non-abrasive methods. These include the use of brushes, air and wet blasting, and high-pressure water cleaning, followed by a wash/rinse process using appropriate cleaning solutions. Use of a solvent rinse is required when organic contamination is present.

1.3 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

1.4 INTERFERENCES AND POTENTIAL PROBLEMS

- The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment

provided that it has been verified by laboratory analysis to be analyte free.

- An untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal water treatment system for mixing of decontamination solutions.
- Acids and solvents utilized in the decontamination sequence pose the health and safety risks of inhalation or skin contact, and raise shipping concerns of permeation or degradation.
- The site work plan must address disposal of the spent decontamination solutions.
- Several procedures can be established to minimize contact with waste and the potential for contamination. For example:
 - Stress work practices that minimize contact with hazardous substances.
 - Use remote sampling, handling, and container-opening techniques when appropriate.
 - Cover monitoring and sampling equipment with protective material to minimize contamination.
 - Use disposable outer garments and disposable sampling equipment when appropriate.

1.5 EQUIPMENT/APPARATUS

- appropriate personal protective clothing
- non-phosphate detergent
- selected solvents
- long-handled brushes
- drop cloths/plastic sheeting
- trash container
- paper towels
- galvanized tubs or buckets
- tap water

- distilled/deionized water
- metal/plastic containers for storage and disposal of contaminated wash solutions
- pressurized sprayers for tap and deionized/distilled water
- sprayers for solvents
- trash bags
- aluminum foil
- safety glasses or splash shield
- emergency eyewash bottle

1.6 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions and solvents. In general, the following solvents are utilized for decontamination purposes:

- 10% nitric acid⁽¹⁾
- acetone (pesticide grade)⁽²⁾
- hexane (pesticide grade)⁽²⁾
- methanol

⁽¹⁾ Only if sample is to be analyzed for trace metals.

⁽²⁾ Only if sample is to be analyzed for organics.

1.7 PROCEDURES

As part of the health and safety plan, develop and set up a decontamination plan before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- the number, location, and layout of decontamination stations
- which decontamination apparatus is needed
- the appropriate decontamination methods
- methods for disposal of contaminated clothing, apparatus, and solutions

1.7.1 Decontamination Methods

All personnel, samples, and equipment leaving the contaminated area of a site must be decontaminated. Various decontamination methods will either physically remove contaminants, inactivate contaminants by disinfection or sterilization, or do both.

In many cases, gross contamination can be removed by physical means. The physical decontamination techniques appropriate for equipment decontamination can be grouped into two categories: abrasive methods and non-abrasive methods.

Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The following abrasive methods are available:

- **Mechanical:** Mechanical cleaning methods use brushes of metal or nylon. The amount and type of contaminants removed will vary with the hardness of bristles, length of brushing time, and degree of brush contact.
- **Air Blasting:** Air blasting is used for cleaning large equipment, such as bulldozers, drilling rigs or auger bits. The equipment used in air blast cleaning employs compressed air to force abrasive material through a nozzle at high velocities. The distance between the nozzle and the surface cleaned, as well as the pressure of air, the time of application, and the angle at which the abrasive strikes the surface, determines cleaning efficiency. Air blasting has several disadvantages: it is unable to control the amount of material removed, it can aerate contaminants, and it generates large amounts of waste.
- **Wet Blasting:** Wet blast cleaning, also used to clean large equipment, involves use of a suspended fine abrasive delivered by compressed air to the contaminated area. The amount of materials removed can be carefully controlled by using very fine abrasives. This method generates a large amount of waste.

Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off of a surface with pressure. In general, less of the equipment surface is removed using non-abrasive methods. The following non-abrasive methods are available:

- **High-Pressure Water:** This method consists of a high-pressure pump, an operator-controlled directional nozzle, and a high pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) which relates to flow rates of 20 to 140 liters per minute.
- **Ultra-High-Pressure Water:** This system produces a pressurized water jet (from 1,000 to 4,000 atm). The ultra-high-pressure spray removes tightly-adhered surface film. The water velocity ranges from 500 m/sec (1,000 atm) to 900 m/sec (4,000 atm). Additives can enhance the method. This method is not applicable for hand-held sampling equipment.

Disinfection/Rinse Methods

- **Disinfection:** Disinfectants are a practical means of inactivating infectious agents.
- **Sterilization:** Standard sterilization methods involve heating the equipment. Sterilization is impractical for large equipment.
- **Rinsing:** Rinsing removes contaminants through dilution, physical attraction, and solubilization.

1.7.2 Field Sampling Equipment Cleaning Procedures

Solvent rinses are not necessarily required when organics are not a contaminant of concern and may be eliminated from the sequence specified below. Similarly, an acid rinse is not required if analysis does not include inorganics.

1. Where applicable, follow physical removal procedures specified in section 1.7.1.
2. Wash equipment with a non-phosphate detergent solution.
3. Rinse with tap water.
4. Rinse with distilled/deionized water.
5. Rinse with 10% nitric acid if the sample will be analyzed for trace organics.

6. Rinse with distilled/deionized water.
7. Use a solvent rinse (pesticide grade) if the sample will be analyzed for organics.
8. Air dry the equipment completely.
9. Rinse again with distilled/deionized water.

Selection of the solvent for use in the decontamination process is based on the contaminants present at the site. Use of a solvent is required when organic contamination is present on-site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. An acid rinse step is required if metals are present on-site. If a particular contaminant fraction is not present at the site, the nine-step decontamination procedure listed above may be modified for site specificity. The decontamination solvent used should not be among the contaminants of concern at the site.

Table 1 lists solvent rinses which may be required for elimination of particular chemicals. After each solvent rinse, the equipment should be air dried and rinsed with distilled/deionized water.

Sampling equipment that requires the use of plastic tubing should be disassembled and the tubing replaced with clean tubing, before commencement of sampling and between sampling locations.

1.8 CALCULATIONS

This section is not applicable to this SOP.

1.9 QUALITY ASSURANCE/ QUALITY CONTROL

One type of quality control sample specific to the field decontamination process is the rinsate blank. The rinsate blank provides information on the effectiveness of the decontamination process employed in the field. When used in conjunction with field blanks and trip blanks, a rinsate blank can detect contamination during sample handling, storage and sample transportation to the laboratory.

Table 1: Recommended Solvent Rinse for Soluble Contaminants

SOLVENT	SOLUBLE CONTAMINANTS
Water	<ul style="list-style-type: none"> • Low-chain hydrocarbons • Inorganic compounds • Salts • Some organic acids and other polar compounds
Dilute Acids	<ul style="list-style-type: none"> • Basic (caustic) compounds • Amines • Hydrazines
Dilute Bases -- for example, detergent and soap	<ul style="list-style-type: none"> • Metals • Acidic compounds • Phenol • Thiols • Some nitro and sulfonic compounds
Organic Solvents ⁽¹⁾ - for example, alcohols, ethers, ketones, aromatics, straight-chain alkanes (e.g., hexane), and common petroleum products (e.g., fuel, oil, kerosene)	<ul style="list-style-type: none"> • Nonpolar compounds (e.g., some organic compounds)

⁽¹⁾ - WARNING: Some organic solvents can permeate and/or degrade protective clothing.

A rinsate blank consists of a sample of analytic-free (i.e., deionized) water which is passed over and through a field decontaminated sampling device and placed in a clean sample container.

Rinsate blanks should be run for all parameters of interest at a rate of 1 per 20 for each parameter, even if samples are not shipped that day. Rinsate blanks are not required if dedicated sampling equipment is used.

1.10 DATA VALIDATION

This section is not applicable to this SOP.

1.11 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and specific health and safety procedures.

Decontamination can pose hazards under certain circumstances even though performed to protect

health and safety. Hazardous substances may be incompatible with decontamination methods. For example, the decontamination solution or solvent may react with contaminants to produce heat, explosion, or toxic products. Decontamination methods may be incompatible with clothing or equipment; some solvents can permeate or degrade protective clothing. Also, decontamination solutions and solvents may pose a direct health hazard to workers through inhalation or skin contact, or if they combust.

The decontamination solutions and solvents must be determined to be compatible before use. Any method that permeates, degrades, or damages personal protective equipment should not be used. If decontamination methods pose a direct health hazard, measures should be taken to protect personnel or the methods should be modified to eliminate the hazard.

2.0 DRUM SAMPLING: SOP #2009

2.1 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide technical guidance on safe and cost-effective response actions at hazardous waste sites containing drums with unknown contents. Container contents are sampled and characterized for disposal, bulking, recycling, grouping, and/or classification purposes.

2.2 METHOD SUMMARY

Prior to sampling, drums must be inventoried, staged, and opened. An inventory entails recording visual qualities of each drum and any characteristics pertinent to the contents' classification. Staging involves the organization, and sometimes consolidation of drums which have similar wastes or characteristics. Opening of closed drums can be performed manually or remotely. Remote drum opening is recommended for worker safety. The most widely used method of sampling a drum involves the use of a glass thief. This method is quick, simple, relatively inexpensive, and requires no decontamination.

2.3 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples collected from drums are considered waste samples. No preservatives should be added since there is a potential reaction of the sample with the preservative. Samples should, however, be cooled to 4°C and protected from sunlight in order to minimize any potential reaction due to the light sensitivity of the sample.

Sample bottles for collection of waste liquids, sludges, or solids are typically wide-mouth amber jars with Teflon-lined screw caps. Actual volume required for analysis should be determined in conjunction with the laboratory performing the analysis.

Follow these waste sample handling procedures:

1. Place sample container in two Ziploc plastic bags.

2. Place each bagged container in a 1-gallon covered can containing absorbent packing material. Place the lid on the can.
3. Mark the sample identification number on the outside of the can.
4. Place the marked cans in a cooler, and fill remaining space with absorbent packing material.
5. Fill out chain of custody form for each cooler, place in plastic, and affix to inside lid of cooler.
6. Secure and custody seal the lid of cooler.
7. Arrange for the appropriate transportation mode consistent with the type of hazardous waste involved.

2.4 INTERFERENCES AND POTENTIAL PROBLEMS

The practice of tapping drums to determine their contents is neither safe nor effective and should not be used if the drums are visually overpressurized or if shock-sensitive materials are suspected. A laser thermometer may be used instead.

Drums that have been overpressurized, to the extent that the head is swollen several inches above the level of the chime, should not be moved. A number of devices have been developed for venting critically swollen drums. One method that has proven to be effective is a tube and spear device. A light aluminum tube (3 meters long) is positioned at the vapor space of the drum. A rigid, hooking device attached to the tube goes over the chime and holds the tube securely in place. The spear is inserted in the tube and positioned against the drum wall. A sharp blow on the end of the spear drives the sharpened tip through the drum and the gas vents along the grooves. The venting should be done from behind a wall or barricade. This device can be cheaply and easily designed and constructed where needed. Once the pressure has been relieved, the bung can be removed and the drum sampled.

2.5 EQUIPMENT/APPARATUS

The following are standard materials and equipment required for sampling:

- personal protection equipment
- wide-mouth glass jars with Teflon cap liner, approximately 500 mL volume
- uniquely numbered sample identification labels with corresponding data sheets
- 1-gallon covered cans half-filled with absorbent (vermiculite)
- chain of custody forms
- decontamination materials
- glass thief tubes or Composite Liquid Waste Samplers (COLIWASA)
- laser thermometer
- drum opening devices

Drum opening devices include the following:

2.5.1 Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of cast iron, brass, or a bronze-beryllium, non-sparking alloy formulated to reduce the likelihood of sparks. The use of a non-sparking bung wrench does not completely eliminate the possibility of a spark being produced. (See Figure 1, Appendix B.)

2.5.2 Drum Deheader

When a bung is not removable with a bung wrench, a drum can be opened manually by using a drum deheader. This tool is constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums. Drums with removable heads must be opened by other means. (See Figure 2, Appendix B.)

2.5.3 Hand Pick, Pickaxe, and Hand Spike

These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most

commonly used are commercially available; whereas the spikes are generally uniquely fabricated 4-foot long poles with a pointed end. (See Figure 3, Appendix B.)

2.5.4 Backhoe Spike

The most common means used to open drums remotely for sampling is the use of a metal spike attached or welded to a backhoe bucket. In addition to being very efficient, this method can greatly reduce the likelihood of personal exposure. (See Figure 4, Appendix B.)

2.5.5 Hydraulic Drum Opener

Another remote method for opening drums is with remotely operated hydraulic devices. One such device uses hydraulic pressure to pierce through the wall of a drum. It consists of a manually operated pump which pressurizes soil through a length of hydraulic line. (See Figure 5, Appendix B.)

2.5.6 Pneumatic Devices

A pneumatic bung remover consists of a compressed air supply that is controlled by a heavy-duty, two-stage regulator. A high-pressure air line of desired length delivers compressed air to a pneumatic drill, which is adapted to turn a bung fitting selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device. (See Figure 6, Appendix B.)

2.6 REAGENTS

Reagents are not typically required for preserving drum samples. However, reagents are used for decontaminating sampling equipment. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

2.7 PROCEDURES

2.7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies are needed.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or preclean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site-specific health and safety plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

2.7.2 Drum Inspection

Appropriate procedures for handling drums depend on the contents. Thus, prior to any handling, drums should be visually inspected to gain as much information as possible about their contents. Those in charge of inspections should be on the look-out for:

- drum condition, corrosion, rust, and leaking contents
- symbols, words, or other markings on the drum indicating hazards (i.e., explosive, radioactive, toxic, flammable)
- signs that the drum is under pressure
- shock sensitivity

Monitor around the drums with radiation instruments, organic vapor monitors (OVA) and combustible gas indicators (CGI).

Classify the drums into categories, for instance:

- radioactive
- leaking/deteriorating
- bulging
- drums containing lab packs
- explosive/shock sensitive

All personnel should assume that unmarked drums contain hazardous materials until their contents have been categorized, and that labels on drums may not accurately describe their contents.

If it is presumed that there are buried drums on-site, geophysical investigation techniques such as magnetometry, ground penetrating radar, and metal detection can be employed in an attempt to determine depth and location of the drums. See ERT SOP #2159, General Surface Geophysics.

2.7.3 Drum Staging

Prior to sampling, the drums should be staged to allow easy access. Ideally, the staging area should be located just far enough from the drum opening area to prevent a chain reaction if one drum should explode or catch fire when opened.

While staging, physically separate the drums into the following categories: those containing liquids, those containing solids, lab packs, or gas cylinders, and those which are empty. This is done because the strategy for sampling and handling drums/containers in each of these categories will be different. This may be achieved by:

- Visual inspection of the drum and its labels, codes, etc. Solids and sludges are typically disposed of in open-top drums. Closed-head drums with a bung opening generally contain liquid.
- Visual inspection of the contents of the drum during sampling followed by restaging, if needed.

Once a drum has been excavated and any immediate hazard has been eliminated by overpacking or transferring the drum's contents, affix a numbered tag to the drum and transfer it to a staging area. Color-coded tags, labels, or bands should be used to mark similar waste types. Record a description of each drum, its condition, any unusual markings, and the location where it was buried or stored, on a drum data sheet (Appendix A). This data sheet becomes the principal

recordkeeping tool for tracking the drum onsite.

Where there is good reason to suspect that some drums contain radioactive, explosive, and shock-sensitive materials, these drums should be staged in a separate, isolated area. Placement of explosives and shock-sensitive materials in diked and fenced areas will minimize the hazard and the adverse effects of any premature detonation of explosives.

Where space allows, the drum opening area should be physically separated from the drum removal and drum staging operations. Drums are moved from the staging area to the drum opening area one at a time using forklift trucks equipped with drum grabbers or a barrel grapppler. In a large-scale drum handling operation, drums may be conveyed to the drum opening area using a roller conveyor.

2.7.4 Drum Opening

There are three basic techniques available for opening drums at hazardous waste sites:

- Manual opening with non-sparking bung wrenches,
- Drum deheading, and
- Remote drum puncturing or bung removal.

The choice of drum opening techniques and accessories depends on the number of drums to be opened, their waste contents, and physical condition. Remote drum opening equipment should always be considered in order to protect worker safety. Under OSHA 1910.120, manual drum opening with bung wrenches or deheaders should be performed only with structurally sound drums having contents that are known to be (1) not shock sensitive, (2) non-reactive, (3) non-explosive, and (4) non-flammable.

Manual Drum Opening with a Bung Wrench

Manual drum opening with bung wrenches (Figure 1, Appendix B) should not be performed unless the drums are structurally sound (no evidence of bulging or deformation) and their contents are known to be non-explosive. If opening the drum with bung wrenches is deemed reasonably cost-effective and safe, then follow these procedures to minimize the hazard:

1. Fully outfit field personnel with protective gear.
2. Position drum upright with the bung up, or, for drums with bungs on the side, lay the drum on its side with the bung plug up.
3. Wrench the bung with a slow, steady pulling motion across the drum. If the length of the bung wrench handle provides inadequate leverage for unscrewing the plug, attach a "cheater bar" to the handle to improve leverage.

Manual Drum Opening with a Drum Deheader

Drums are opened with a drum deheader (Figure 2, Appendix B) by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will cut off the entire top. If the top chime of a drum has been damaged or badly dented, it may not be possible to cut off the entire top. Since there is always the possibility that a drum may be under pressure, make the initial cut very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to use a remote method to puncture the drum prior to using the deheader.

Self-propelled drum openers which are either electrically or pneumatically driven can be used for quicker and more efficient deheading.

Manual Drum Opening with a Hand Pick, Pickaxe, or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, the drum can be opened for sampling by using a hand pick, pickaxe, or spike (Figure 3, Appendix B). Often the drum lid or head must be hit with a great deal of force in order to penetrate it. The potential for splash or spraying is greater than with other opening methods and, therefore, this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums cannot be opened slowly with these tools, spray from drums is common requiring appropriate safety measures. Decontaminate the pick or spike after each drum is opened to avoid cross-contamination and/or adverse chemical reaction from incompatible materials.

Remote Drum Opening with a Backhoe Spike

Remotely operated drum opening tools are the safest available means of drum opening. Remote drum opening is slow, but is much safer compared to manual methods of opening.

Drums should be "staged" or placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike (Figure 4, Appendix B) should be decontaminated after each drum is opened to prevent cross-contamination. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This, combined with the required level of personal protection gear, should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system.

Remote Drum Opening with Hydraulic Devices

A piercing device with a metal point is attached to the end of a hydraulic line and is pushed into the drum by hydraulic pressure (Figure 5, Appendix B). The piercing device can be attached so that the sampling hole can be made on either the side or the head of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place if desired and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

Remote Drum Opening with Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely (Figure 6, Appendix B).

2.7.5 Drum Sampling

After the drum has been opened, monitor headspace gases using an explosimeter and organic vapor analyzer. In most cases it is impossible to observe the contents of these sealed or partially sealed vessels. Since some layering or stratification is likely in any solution left undisturbed over time, take a sample that represents the entire depth of the vessel.

When sampling a previously sealed vessel, check for the presence of a bottom sludge. This is easily accomplished by measuring the depth to the apparent bottom, then comparing it to the known interior depth.

Glass Thief Sampler

The most widely used implement for sampling is a glass tube commonly referred to as a glass thief (Figure 7, Appendix B). This tool is simple, cost effective, quick, and collects a sample without having to decontaminate. Glass thieves are typically 6mm to 16mm I.D. and 48 inches long.

Procedures for using a glass thief are as follows:

1. Remove cover from sample container.
2. Insert glass tubing almost to the bottom of the drum or until a solid layer is encountered. About one foot of tubing should extend above the drum.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the sampling tube with a tapered stopper or thumb, ensuring liquid does not come into contact with stopper.
5. Carefully remove the capped tube from the drum and insert the uncapped end in the sample container.
6. Release stopper and allow the glass thief to drain until the container is approximately 2/3 full.
7. Remove tube from the sample container, break it into pieces and place the pieces in the drum.

8. Cap the sample container tightly and place prelabeled sample container in a carrier.
9. Replace the bung or place plastic over the drum.
10. Log all samples in the site logbook and on field data sheets.
11. Package samples and complete necessary paperwork.
12. Transport sample to decontamination zone to prepare it for transport to the analytical laboratory.

In many instances a drum containing waste material will have a sludge layer on the bottom. Slow insertion of the sample tube down into this layer and then a gradual withdrawal will allow the sludge to act as a bottom plug to maintain the fluid in the tube. The plug can be gently removed and placed into the sample container by the use of a stainless steel lab spoon.

It should be noted that in some instances disposal of the tube by breaking it into the drum may interfere with eventual plans for the removal of its contents. This practice should be cleared with the project officer or other disposal techniques evaluated.

COLIWASA Sampler

Some equipment is designed to collect a sample from the full depth of a drum and maintain it in the transfer tube until delivery to the sample bottle. These designs include primarily the Composite Liquid Waste Sampler (COLIWASA) and modifications thereof. The COLIWASA (Figure 8, Appendix B) is a much cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. One configuration consists of a 152 cm by 4 cm I.D. section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end.

Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. One model of the COLIWASA is shown in Appendix B; however, the design can be modified and/or adapted somewhat to meet the needs of the sampler.

The major drawbacks associated with using a COLIWASA concern decontamination and costs. The sampler is difficult, if not impossible to decontaminate in the field and its high cost in relation to alternative procedures (glass tubes) make it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Follow these procedures for using the COLIWASA:

1. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.
2. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.
3. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.
4. Slowly withdraw the sample from the waste container with one hand while wiping the sampler tube with a disposable cloth or rag with the other hand.
5. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.
6. Cap the sample container tightly and place prelabeled sample container in a carrier.
7. Replace the bung or place plastic over the drum.
8. Log all samples in the site logbook and on field data sheets.

9. Package samples and complete necessary paperwork.
10. Transport sample to decontamination zone to prepare it for transport to the analytical laboratory.

2.8 CALCULATIONS

This section is not applicable to this SOP.

2.9 QUALITY ASSURANCE/ QUALITY CONTROL

The following general quality assurance procedures apply:

- Document all data on standard chain of custody forms, field data sheets, or within site logbooks.
- Operate all instrumentation in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

2.10 DATA VALIDATION

This section is not applicable to this SOP.

2.11 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and specific health and safety procedures.

The opening of closed containers is one of the most hazardous site activities. Maximum efforts should be made to ensure the safety of the sampling team. Proper protective equipment and a general awareness of the possible dangers will minimize the risk inherent in sampling operations. Employing proper drum-opening techniques and equipment will also safeguard personnel. Use remote sampling equipment whenever feasible.

3.0 TANK SAMPLING: SOP #2010

3.1 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide protocols for sampling tanks and other confined spaces from outside the vessel.

3.2 METHOD SUMMARY

The safe collection of a representative sample should be the criterion for selecting sample locations. A representative sample can be collected using techniques or equipment that are designed for obtaining liquids or sludges from various depths. The structure and characteristics of storage tanks present problems with collection of samples from more than one location; therefore, the selection of sampling devices is an important consideration.

Depending on the type of vessel and characteristics of the material to be sampled, one can choose a bailer, glass thief, bacon bomb sampler, sludge judge, COLIWASA, or subsurface grab sampler to collect the sample. For depths of less than 5-feet, a bailer, COLIWASA, or sludge judge can be used. A sludge judge, subsurface grab sampler, bailer, or bacon bomb sampler can be used for depths greater than 5-feet. A sludge judge or bacon bomb can be used to determine if the tank consists of various strata.

All sample locations should be surveyed for air quality prior to sampling. At no time should sampling continue with an LEL reading greater than 25%.

All personnel involved in tank sampling should be advised as to the hazards associated with working in unfavorable conditions.

3.3 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples collected from tanks are considered waste samples and, as such, addition of preservatives is not required due to the potential reaction of the sample with the preservative. Samples should,

however, be cooled to 4°C and protected from sunlight in order to minimize any potential reaction due to the light sensitivity of the sample.

Sample bottles for collection of waste liquids, sludges, or solids are typically wide-mouth amber jars with Teflon-lined screw caps. Actual volume required for analysis should be determined in conjunction with the laboratory performing the analysis.

Waste sample handling procedures should be as follows:

1. Place sample container in two Ziploc plastic bags.
2. Place each bagged container in a 1-gallon covered can containing absorbent packing material. Place the lid on the can.
3. Mark the sample identification number on the outside of the can.
4. Place the marked cans in a cooler, and fill remaining space with absorbent packing material.
5. Fill out a chain of custody form for each cooler, place it in plastic, and affix it to the inside lid of the cooler.
6. Secure and custody seal the lid of cooler.
7. Arrange for the transportation appropriate for the type of hazardous waste involved.

3.4 INTERFERENCES AND POTENTIAL PROBLEMS

Sampling a storage tank requires a great deal of manual dexterity, often requiring the sampler to climb to the top of the tank upon a narrow vertical or spiral stairway or ladder while wearing protective clothing and carrying sampling equipment.

Before climbing onto the vessel, perform a structural survey of the tank to ensure the sampler's

safety and accessibility prior to initiating field activities.

As in all opening of containers, take extreme caution to avoid ignition or combustion of volatile contents. All tools used must be constructed of a non-sparking material and electronic instruments must be intrinsically safe.

All sample locations should be surveyed for air quality prior to sampling. At no time should sampling continue with an LEL reading greater than 25%.

3.5 EQUIPMENT/APPARATUS

Storage tank materials include liquids, sludges, still bottoms, and solids of various structures. The type of sampling equipment chosen should be compatible with the waste. Samplers commonly used for tanks include: the bacon bomb sampler, the sludge judge, glass thief, bailer, COLIWASA, and subsurface grab sampler.

- sampling plan
- safety equipment
- tape measure
- weighted tape line or equivalent
- camera/film
- stainless steel bucket or bowl
- sample containers
- Ziploc plastic bags
- logbook
- labels
- field data sheets
- chain of custody forms
- flashlight (explosion proof)
- coolers
- ice
- decontamination supplies
- bacon bomb sampler
- sludge judge
- glass thief
- bailer
- COLIWASA
- subsurface grab sampler
- water/oil level indicator
- OVA (organic vapor analyzer or equivalent)
- explosimeter/oxygen meter
- high volume blower

3.6 REAGENTS

Reagents are not typically required for the preservation of waste samples. However, reagents will be utilized for decontamination of equipment. Decontamination solutions required are specified in ERT SOP #2006, Sampling Equipment Decontamination.

3.7 PROCEDURES

3.7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies are needed.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or preclean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site-specific health and safety plan.
6. Identify and mark all sampling locations.

3.7.2 Preliminary Inspection

1. Inspect the external structural characteristics of each tank and record in the site logbook. Potential sampling points should be evaluated for safety, accessibility, and sample quality.
2. Prior to opening a tank for internal inspection, the tank sampling team should:
 - Review safety procedures and emergency contingency plans with the Safety Officer,
 - Ensure that the tank is properly grounded,
 - Remove all sources of ignition from the immediate area.
3. Each tank should be mounted using appropriate means. Remove manway covers using non-sparking tools.

4. Collect air quality measurements for each potential sample location using an explosimeter/oxygen meter for a lower explosive limit (LEL/O₂) reading and an OVA/HNU for an organic vapor concentration. Both readings should be taken from the tank headspace, above the sampling port, and in the breathing zone.
5. Prior to sampling, the tank headspace should be cleared of any toxic or explosive vapor concentration using a high volume blower. No work should start if LEL readings exceed 25%. At 10% LEL, work can continue but with extreme caution.
5. Measure the outside diameter of the tank and determine the volume of wastes using the depth measurements. (See Appendix C for calculations.)
6. Sludges can be collected using a bacon bomb sampler, glass thief, or sludge judge.
7. Record all information on the sample data sheet or site logbook. Label the container with the appropriate sample tag.
8. Decontaminate sampling equipment as per ERT SOP #2006, Sampling Equipment Decontamination.

3.7.3 Sampling Procedures

1. Determine the depth of any and all liquid-solid interface, and depth of sludge using a weighted tape measure, probe line, sludge judge, or equivalent.
2. Collect liquid samples from 1-foot below the surface, from mid-depth of liquid, and from 1-foot above the bottom sludge layer. This can be accomplished with a subsurface grab sampler or bacon bomb. For liquids less than 5-feet in depth, use a glass thief or COLIWASA to collect the sample.

If sampling storage tanks, vacuum trucks, or process vessels, collect at least one sample from each compartment in the tank. Samples should always be collected through an opened hatch at the top of the tank. Valves near the bottom should not be used, because of their questionable or unknown integrity. If such a valve cannot be closed once opened, the entire tank contents may be lost to the ground surface. Also, individual strata cannot be sampled separately through a valve near the bottom.

3. Compare the three samples for visual phase differences. If phase differences appear, systematic iterative sampling should be performed. By halving the distance between two discrete sampling points, one can determine the depth of the phase change.
4. If another sampling port is available, sample as above to verify the phase information.

3.7.4 Sampling Devices

Bacon Bomb Sampler

The bacon bomb sampler (Figure 9, Appendix B) is designed to collect material from various levels within a storage tank. It consists of a cylindrical body, usually made of chrome-plated brass and bronze with an internal tapered plunger that acts as a valve to admit the sample. A line attached to the top of the plunger opens and closes the valve. A line is attached to the removable top cover which has a locking mechanism to keep the plunger closed after sampling.

1. Attach the sample line and the plunger line to the sampler.
2. Measure and then mark the sampling line at the desired depth.
3. Gradually lower the bacon bomb sampler by the sample line until the desired level is reached.
4. When the desired level is reached, pull up on the plunger line and allow the sampler to fill before releasing the plunger line to seal off the sampler.
5. Retrieve the sampler by the sample line. Be careful not to pull up on the plunger line and thereby prevent accidental opening of the bottom valve.
6. Rinse or wipe off the exterior of the sampler body.

7. Position the sampler over the sample container and release its contents by pulling up on the plunger line.
8. Cap the sample container tightly and place prelabeled sample container in a carrier.
9. Replace the bung or place plastic over the tank.
10. Log all samples in the site logbook and on field data sheets and label all samples.
11. Package samples and complete necessary paperwork.
12. Transport sample to decontamination zone to prepare it for transport to the analytical laboratory.

Sludge Judge

A sludge judge (Figure 10, Appendix B) is used for obtaining an accurate reading of solids which can settle, in any liquid, to any depth. The sampler consists of 3/4-inch plastic pipe in 5-foot sections, marked at 1-foot increments, with screw-style fittings. The top section includes a nylon line for raising the sampler.

1. Lower the sludge judge to the bottom of the tank.
2. When the bottom has been reached, and the pipe has filled to surface level, tug slightly on the rope as you begin to raise the unit. This will seat the check valve, trapping the column of material.
3. When the unit has been raised clear of the tank liquid, the amount of sludge in the sample can be read using the 1-foot increments marked on the pipe sections.
4. By touching the pin extending from the bottom section against a hard surface, the material is released from the unit.
5. Cap the sample container tightly and place prelabeled sample container in a carrier.
6. Replace the bung or place plastic over the tank.
7. Log all samples in the site logbook and on field data sheets and label all samples.

8. Package samples and complete necessary paperwork.
9. Transport sample to decontamination zone to prepare it for transport to the analytical laboratory.

Subsurface Grab Sampler

Subsurface grab samplers (Figure 11, Appendix B) are designed to collect samples of liquids at various depths. The sampler is usually constructed of aluminum or stainless steel tubing with a polypropylene or Teflon head that attaches to a 1-liter sample container.

1. Screw the sample bottle onto the sampling head.
2. Lower the sampler to the desired depth.
3. Pull the ring at the top which opens the spring-loaded plunger in the head assembly.
4. When the bottle is full, release the ring, lift sampler, and remove sample bottle.
5. Cap the sample container tightly and place prelabeled sample container in a carrier.
6. Replace the bung or place plastic over the tank.
7. Log all samples in the site logbook and on field data sheets and label all samples.
8. Package samples and complete necessary paperwork.
9. Transport sample to decontamination zone to prepare it for transport to the analytical laboratory.

Glass Thief

The most widely used implement for sampling is a glass tube commonly referred to as a glass thief (Figure 7, Appendix B). This tool is simple, cost effective, quick, and collects a sample without having to decontaminate. Glass thieves are typically 6mm to 16mm I.D. and 48 inches long.

1. Remove cover from sample container.
2. Insert glass tubing almost to the bottom of the

tank or until a solid layer is encountered. About 1 foot of tubing should extend above the tank.

3. Allow the waste in the tank to reach its natural level in the tube.
4. Cap the top of the sampling tube with a tapered stopper or thumb, ensuring liquid does not come into contact with stopper.
5. Carefully remove the capped tube from the tank and insert the uncapped end in the sample container. Do not spill liquid on the outside of the sample container.
6. Release stopper and allow the glass thief to drain until the container is approximately 2/3 full.
7. Remove tube from the sample container, break it into pieces and place the pieces in the tank.
8. Cap the sample container tightly and place prelabeled sample container in a carrier.
9. Replace the bung or place plastic over the tank.
10. Log all samples in the site logbook and on field data sheets and label all samples.
11. Package samples and complete necessary paperwork.
12. Transport sample to decontamination zone to prepare it for transport to the analytical laboratory.

In many instances a tank containing waste material will have a sludge layer on the bottom. Slow insertion of the sample tube down into this layer and then a gradual withdrawal will allow the sludge to act as a bottom plug to maintain the fluid in the tube. The plug can be gently removed and placed into the sample container by the use of a stainless steel lab spoon.

Bailer

The positive-displacement volatile sampling bailer (manufactured by GPI or equivalent) (Figure 12, Appendix B) is perhaps the most appropriate for collecting water samples for volatile analysis. Other bailer types (messenger, bottom fill, etc.) are less

desirable, but may be mandated by cost and site conditions. Generally, bailers can provide an acceptable sample, providing that the sampling personnel use extra care in the collection process.

1. Make sure clean plastic sheeting surrounds the tank.
2. Attach a line to the bailer.
3. Lower the bailer slowly and gently into the tank so as not to splash the bailer into the tank contents.
4. Allow the bailer to fill completely and retrieve the bailer from the tank.
5. Begin slowly pouring from the bailer.
6. Cap the sample container tightly and place prelabeled sample container in a carrier.
7. Replace the bung or place plastic over the tank.
8. Log all samples in the site logbook and on field data sheets and label all samples.
9. Package samples and complete necessary paperwork.
10. Transport sample to decontamination zone to prepare it for transport to an analytical laboratory.

COLIWASA

Some equipment is designed to collect a sample from the full depth of a tank and maintain it in the transfer tube until delivery to the sample bottle. These designs include primarily the Composite Liquid Waste Sampler (COLIWASA) (Figure 8, Appendix B) and modifications thereof. The COLIWASA is a much cited sampler designed to permit representative sampling of multiphase wastes from tanks and other containerized wastes. One configuration consists of a 152 cm by 4 cm I.D. section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end. Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper.

The major drawbacks associated with using a COLIWASA concern decontamination and costs. The sampler is difficult if not impossible to decontaminate in the field and its high cost in relation to alternative procedures (glass tubes) make it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

1. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.
2. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.
3. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.
4. Slowly withdraw the sample from the waste container with one hand while wiping the sampler tube with a disposable cloth or rag with the other hand.
5. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.
6. Cap the sample container tightly and place prelabeled sample container in a carrier.
7. Replace the bung or place plastic over the tank.
8. Log all samples in the site logbook and on field data sheets and label all samples.
9. Package samples and complete necessary paperwork.
10. Transport sample to decontamination zone to

prepare it for transport to the analytical laboratory.

3.8 CALCULATIONS

Refer to Appendix C for calculations to determine tank volumes.

3.9 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

- All data must be documented on field data sheets or within site logbooks.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

3.10 DATA VALIDATION

This section is not applicable to this SOP.

3.11 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and specific health and safety procedures. More specifically, the hazards associated with tank sampling may cause bodily injury, illness, or death to the worker. Failure to recognize potential hazards of waste containers is the cause of most accidents. It should be assumed that the most unfavorable conditions exist, and that the danger of explosion and poisoning will be present. Hazards specific to tank sampling are:

- Hazardous atmospheres can be flammable, toxic, asphyxiating, or corrosive.
- If activating electrical or mechanical equipment would cause injury, each piece of equipment should be manually isolated

to prevent inadvertent activation while workers are occupied.

- Communication is of utmost importance between the sampling worker and the standby person to prevent distress or injury going unnoticed. The Illuminating Engineers Society Lighting Handbook requires suitable illumination to provide sufficient visibility for work.
- Noise reverberation may disrupt verbal communication with standby personnel.
- Tank vibration may affect multiple body parts and organs of the sampler depending on vibration characteristics.
- General hazards include falling scaffolding, surface residues (which could cause electrical shock, incompatible material reactions, slips, or falls), and structural objects (including baffles/trays in horizontal/vertical tanks, and overhead structures).

4.0 CHIP, WIPE, AND SWEEP SAMPLING: SOP #2011

4.1 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) outlines the recommended protocol and equipment for collection of representative chip, wipe, and sweep samples to monitor potential surficial contamination.

This method of sampling is appropriate for surfaces contaminated with non-volatile species of analytes (i.e., PCB, PCDD, PCDF, metals, cyanide, etc.) Detection limits are analyte specific. Sample size should be determined based upon the detection limit desired and the amount of sample requested by the analytical laboratory. Typical sample area is 1 square foot. However, based upon sampling location, the area may need modification due to area configuration.

4.2 METHOD SUMMARY

Since surface situations vary widely, no universal sampling method can be recommended. Rather, the method and implements used must be tailored to suit a specific sampling site. The sampling location should be selected based upon the potential for contamination as a result of manufacturing processes or personnel practices.

Chip sampling is appropriate for porous surfaces and is generally accomplished with either a hammer and chisel, or an electric hammer. The sampling device should be laboratory cleaned and wrapped in clean, autoclaved aluminum foil until ready for use. To collect the sample, a measured and marked off area is chipped both horizontally and vertically to an even depth of 1/8 inch. The sample is then transferred to the proper sample container.

Wipe samples are collected from smooth surfaces to indicate surficial contamination; a sample location is measured and marked off. Sampling personnel wear a new pair of surgical gloves to open a sterile gauze pad, and then soak it with solvent. The solvent used is dependent on the surface being sampled. This pad is then stroked firmly over the sample surface, first vertically, then horizontally, to ensure complete coverage. The pad is then transferred to the sample container.

Sweep sampling is an effective method for the collection of dust or residue on porous or non-porous surfaces. To collect such a sample, an appropriate area is measured off. Then, while wearing a new pair of disposable surgical gloves, sampling personnel use a dedicated brush to sweep material into a dedicated dust pan. The sample is then transferred to the proper sample container.

Samples collected by all three methods are sent to the laboratory for analysis.

4.3 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples should be stored out of direct sunlight to reduce photodegradation and shipped on ice (4°C) to the laboratory performing the analysis. Appropriately-sized, laboratory-cleaned, glass sample jars should be used for sample collection. The amount of sample required is determined in concert with the analytical laboratory.

4.4 INTERFERENCES AND POTENTIAL PROBLEMS

This method has few significant interferences or problems. Typical problems result from rough porous surfaces which may be difficult to wipe, chip, or sweep.

4.5 EQUIPMENT/APPARATUS

- lab-clean sample containers of proper size and composition
- field and travel blanks
- site logbook
- sample analysis request forms
- chain of custody forms
- custody seals
- sample labels
- disposable surgical gloves
- sterile wrapped gauze pad (3 in. x 3 in.)
- appropriate pesticide (HPLC) grade solvent

- medium-sized, laboratory-cleaned paint brush
- medium-sized, laboratory-cleaned chisel
- autoclaved aluminum foil
- camera
- hexane (pesticide/HPLC grade)
- iso-octane
- distilled/deionized water

4.6 REAGENTS

Reagents are not required for preservation of chip, wipe or sweep samples. However, reagents will be utilized for decontamination of sampling equipment. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

4.7 PROCEDURES

4.7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agencies, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site-specific health and safety plan.
6. Mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

4.7.2 Chip Sample Collection

Sampling of porous surfaces is generally accomplished by using a chisel and hammer or electric hammer. The sampling device should be laboratory cleaned or field decontaminated as per ERT SOP# 2006, Sampling Equipment Decontamination. It is then wrapped in cleaned,

autoclaved aluminum foil. The sampler should remain in this wrapping until it is needed. Each sampling device should be used for only one sample.

1. Choose appropriate sampling points; measure off the designated area and photo document.
2. To facilitate later calculations, record surface area to be chipped.
3. Don a new pair of disposable surgical gloves.
4. Open a laboratory-cleaned chisel or equivalent sampling device.
5. Chip the sample area horizontally, then vertically to an even depth of approximately 1/8 inch.
6. Place the sample in an appropriately-prepared sample container with a Teflon-lined cap.
7. Cap the sample container, attach the label and custody seal, and place in a double plastic bag. Record all pertinent data in the site logbook. Complete the sampling analysis request form and chain of custody form before taking the next sample.
8. Store samples out of direct sunlight and cool to 4°C.
9. Leave contaminated sampling device in the sampled material, unless decontamination is practical.
10. Follow proper decontamination procedures, then deliver sample(s) to the laboratory for analysis.

4.7.3 Wipe Sample Collection

Wipe sampling is accomplished by using a sterile gauze pad, adding a solvent in which the contaminant is most soluble, then wiping a pre-determined, pre-measured area. The sample is packaged in an amber jar to prevent photodegradation and packed in coolers for shipment to the lab. Each gauze pad is used for only one wipe sample.

1. Choose appropriate sampling points; measure off the designated area and photo document.

2. To facilitate later calculations, record surface area to be wiped.
3. Don a new pair of disposable surgical gloves.
4. Open new sterile package of gauze pad.
5. Soak the pad with the appropriate solvent.
6. Wipe the marked surface area using firm strokes. Wipe vertically, then horizontally to ensure complete surface coverage.
7. Place the gauze pad in an appropriately prepared sample container with a Teflon-lined cap.
8. Cap the sample container, attach the label and custody seal, and place in a double plastic bag. Record all pertinent data in the site logbook. Complete the sampling analysis request form and chain of custody form before taking the next sample.
9. Store samples out of direct sunlight and cool to 4°C.
10. Follow proper decontamination procedures, then deliver sample(s) to the laboratory for analysis.

4.7.4 Sweep Sample Collection

Sweep sampling is appropriate for bulk contamination. This procedure utilizes a dedicated, hand-held sweeper brush to acquire a sample from a pre-measured area.

1. Choose appropriate sampling points; measure off the designated area and photo document.
2. To facilitate later calculations, record the surface area to be swept.
3. Don a new pair of disposable surgical gloves.
4. Sweep the measured area using a dedicated brush; collect the sample in a dedicated dust pan.
5. Transfer sample from dust pan to sample container.
6. Cap the sample container, attach the label and

custody seal, and place in a double plastic bag. Record all pertinent data in the site logbook. Complete the sampling analysis request form and chain of custody form before taking the next sample.

7. Store samples out of direct sunlight and cool to 4°C.
8. Leave contaminated sampling device in the sample material, unless decontamination is practical.
9. Follow proper decontamination procedures, then deliver sample(s) to the laboratory for analysis.

4.8 CALCULATIONS

Results are usually provided in mg/g, µg/g or another appropriate weight per unit weight measurement. Results may also be given in a mass per unit area.

4.9 QUALITY ASSURANCE/ QUALITY CONTROL

The following general quality assurance procedures apply:

- All data must be documented on standard chain of custody forms, field data sheets or within the site logbook.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

The following specific quality assurance activities apply to wipe samples:

- A blank should be collected for each sampling event. This consists of a sterile gauze pad, wet with the appropriate solvent, and placed in a prepared sample container. The blank will help identify potential introduction of contaminants via

the sampling methods, the pad, solvent or sample container.

- Spiked wipe samples can also be collected to better assess the data being generated. These are prepared by spiking a piece of foil of known area with a standard of the analyte of choice. The solvent containing the standard is allowed to evaporate, and the foil is wiped in a manner identical to the other wipe samples.

Specific quality assurance activities for chip and sweep samples should be determined on a site-specific basis.

4.10 DATA VALIDATION

Review the quality control samples and use the data to qualify the environmental results.

4.11 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and specific health and safety procedures.

5.0 WASTE PILE SAMPLING: SOP #2017

5.1 SCOPE AND APPLICATION

The objective of this Standard Operating Procedure (SOP) is to outline the equipment and methods used in collecting representative samples from waste piles, sludges or other solid or liquid waste mixed with soil.

5.2 METHOD SUMMARY

Stainless steel shovels or scoops should be used to clear away surface material before samples are collected. For samples at depth, a decontaminated auger may be required to advance the hole, then another decontaminated auger used for sample collection. For a sample core, thin-wall tube samplers or grain samplers may be used. Near surfaces samples can be collected with a clean stainless steel spoon or trowel.

All samples collected, except those for volatile organic analysis, should be placed into a Teflon-lined or stainless steel pail and mixed thoroughly before being transferred to an appropriate sample container.

5.3 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Chemical preservation of solids is generally not recommended. Refrigeration to 4°C is usually the best approach, supplemented by a minimal holding time.

Wide mouth glass containers with Teflon-lined caps are typically used for waste pile samples. Sample volume required is a function of the analytical requirements and should be specified in the work plan.

5.4 INTERFERENCES AND POTENTIAL PROBLEMS

There are several variables involved in waste sampling, including shape and size of piles,

compactness, and structure of the waste material. Shape and size of waste material or waste piles vary greatly in areal extent and height. Since state and federal regulations often require a specified number of samples per volume of waste, size and shape must be used to calculate volume and to plan for the correct number of samples. Shape must also be accounted for when planning physical access to the sampling point and when selecting the appropriate equipment to successfully collect the sample at that location.

Material to be sampled may be homogeneous or heterogeneous. Homogeneous material resulting from known situations may not require an extensive sampling protocol. Heterogeneous and unknown wastes require more extensive sampling and analysis to ensure the different components are being represented.

The term "representative sample" is commonly used to denote a sample that has the properties and composition of the population from which it was collected, in the same proportions as found in the population. This can be misleading unless one is dealing with a homogenous waste from which one sample can represent the whole population.

The usual options for obtaining the most "representative sample" from waste piles are simple or stratified random sampling. Simple random sampling is the method of choice unless (1) there are known distinct strata; (2) one wants to prove or disprove that there are distinct strata; or (3) one is limited in the number of samples and desires to minimize the size of a "hot spot" that could go unsampled. If any of these conditions exist, stratified random sampling would be the better strategy.

This strategy, however, can be employed only if all points within the pile can be accessed. In such cases, the pile should be divided into a three-dimensional grid system; the grid sections assigned numbers; and the sampling points chosen using random-number tables or random-number generators. The only exceptions to this are situations in which representative samples cannot be collected safely or where the investigative team is trying to determine worst-case conditions.

If sampling is limited to certain portions of the pile, a statistically based sample will be representative only of that portion, unless the waste is homogenous.

5.5 EQUIPMENT/APPARATUS

Waste pile solids include powdered, granular, or block materials of various sizes, shapes, structure, and compactness. The type of sampler chosen should be compatible with the waste. Samplers commonly used for waste piles include: stainless steel scoops, shovels, trowels, spoons, and stainless steel hand augers, sampling triers, and grain samplers.

Waste pile sampling equipment check list:

- sampling plan
- maps/plot plan
- safety equipment, as specified in the health and safety plan
- compass
- tape measure
- survey stakes or flags
- camera and film
- stainless steel, plastic, or other appropriate homogenization bucket or bowl
- 1-quart mason jars w/Teflon liners
- Ziploc plastic bags
- logbook
- labels
- chain of custody forms and seals
- field data sheets
- cooler(s)
- ice
- decontamination supplies/equipment
- canvas or plastic sheet
- spade or shovel
- spatula
- scoop
- plastic or stainless steel spoons
- trowel
- continuous flight (screw) auger
- bucket auger
- post hole auger
- extension rods
- T-handle
- thin-wall tube sampler
- sampling trier
- grain sampler

5.6 REAGENTS

No chemical reagents are used for the preservation of waste pile samples; however, decontamination solutions may be required. If decontamination of equipment is required, refer to ERT Standard Operating Procedure (SOP) #2006, Sampling Equipment Decontamination, and the site-specific work plan.

5.7 PROCEDURES

5.7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies are required.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or preclean equipment, and ensure that it is in working order.
4. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site-specific health and safety plan.
6. Use stakes or flagging to identify and mark all sampling locations. Specific site factors, including extent and nature of contaminants, should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

5.7.2 Sample Collection

SAMPLING WITH SHOVELS AND SCOOPS

Collection of samples from surface portions of the pile can be accomplished with tools such as spades, shovels, and scoops. Surface material can be removed to the required depth with this equipment, then a stainless steel or plastic scoop can be used to collect the sample.

Accurate, representative samples can be collected with this procedure depending on the care and

precision demonstrated by sample team members. Use of a flat, pointed mason trowel to cut a block of the desired material can be helpful when undisturbed profiles are required. A stainless steel scoop, lab spoon, or plastic spoon will suffice in most other applications. Care should be exercised to avoid the use of devices plated with chrome or other materials. Plating is particularly common with implements such as garden trowels.

Use the following procedure to collect surface samples:

1. Carefully remove the top layer of material to the desired sample depth with a precleaned spade.
2. Using a precleaned stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of material from the area which came in contact with the spade.
3. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, plastic lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

SAMPLING WITH AUGERS AND THIN-WALL TUBE SAMPLERS

This system consists of an auger, a series of extensions, a "T" handle, and a thin-wall tube sampler (Figure 13, Appendix B). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the auger. If a core sample is to be collected, the auger tip is then replaced with a thin-wall tube sampler. The system is then lowered down the borehole, and driven into the pile at the completion depth. The system is withdrawn

and the core collected from the thin-wall tube sampler.

Several augers are available. These include: bucket, continuous flight (screw), and post hole augers. Bucket augers are better for direct sample recovery since they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights, which are usually at 5-foot intervals. The continuous flight augers are satisfactory for use when a composite of the complete waste pile column is desired. Post hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy areas.

Use the following procedure for collecting waste pile samples with the auger:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.
2. Clear the area to be sampled of any surface debris. It may be advisable to remove the first 3 to 6 inches of surface material for an area approximately 6 inches in radius around the drilling location.
3. Begin augering, periodically removing and depositing accumulated materials onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.
4. After reaching the desired depth, slowly and carefully remove the auger from boring. When sampling directly from the auger, collect sample after the auger is removed from boring and proceed to Step 10.
5. Remove auger tip from drill rods and replace with a precleaned thin-wall tube sampler. Install proper cutting tip.
6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the pile. Care should be taken to avoid scraping the borehole sides. Avoid hammering the drill rods to facilitate coring as the vibrations may cause the boring walls to collapse.

7. Remove the tube sampler, and unscrew the drill rods.
8. Remove the cutting tip and the core from device.
9. Discard the top of the core (approximately 1-inch), as this represents material collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required.
10. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, plastic lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.
11. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.
2. Rotate the trier once or twice to cut a core of material.
3. Slowly withdraw the trier, making sure that the slot is facing upward.
4. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, plastic lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are being collected, place samples from the other sampling intervals into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

SAMPLING WITH A TRIER

This system consists of a trier and a "T" handle. The auger is driven into the waste pile and used to extract a core sample from the appropriate depth.

Use the following procedure to collect waste pile samples with a sampling trier:

1. Insert the trier (Figure 14, Appendix B) into the material to be sampled at a 0° to 45° angle from horizontal. This orientation minimizes spillage of the sample. Extraction of the samples might require tilting of the sample containers.

SAMPLING WITH A GRAIN SAMPLER

The grain sampler (Figure 15, Appendix B) is used for sampling powdered or granular wastes or materials in bags, fiberdrums, sacks, similar containers or piles. This sampler is most useful when the solids are no greater than 0.6 cm (1/4 inch) in diameter.

This sampler consists of two slotted telescoping brass or stainless steel tubes. The outer tube has a conical, pointed tip at one end that permits the sampler to penetrate the material being sampled. The sampler is opened and closed by rotating the inner tube. Grain samplers are generally 61 to 100 cm (24 to 40 inch) long by 1.27 to 2.54 cm (1/2 to 1 inch) in diameter and are commercially available at laboratory supply houses.

Use the following procedures to collect waste pile samples with a grain sampler:

1. With the sampler in the closed position, insert it into the granular or powdered material or waste being sampled from a point near a top edge or corner, through the center, and to a point diagonally opposite the point of entry.

2. Rotate the sampler inner tube into the open position.
3. Wiggle the sampler a few times to allow material to enter the open slots.
4. With the sampler in the closed position, withdraw it from the material being sampled.
5. Place the sampler in a horizontal position with the slots facing upward.
6. Rotate the outer tube and slide it away from the inner tube.
7. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, plastic lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

5.8 CALCULATIONS

This section is not applicable to this SOP.

5.9 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following QA procedures apply:

- All data must be documented on field data sheets or within site logbooks.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

5.10 DATA VALIDATION

This section is not applicable to this SOP.

5.11 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and specific health and safety procedures.

APPENDIX A

Drum Data Sheet Form

Drum Data Sheet Form

SOP #2009

Drum ID#: _____

Date Sampled: _____

Estimated Liquid Quantity: _____

Time: _____

Grid Location: _____

Staging Location: _____

Sampler's Name: _____

Drum Condition: _____

Sampling Device: _____

Physical Appearance of the Drum/Bulk Contents: _____

Odor: _____

Color: _____

pH: _____ % Liquid: _____

Laboratory Analytical Data: _____

Date of Analysis: _____

Compatibility: _____

Hazard: _____

Waste ID: _____

Treatment Disposal Recommendations: _____

Approval

Lab: _____

Date: _____

Site Manager: _____

Date: _____

* Area of site where drum was originally located.

Based on di Napoli, 1982. Table originally printed in the Proceedings of the National Conference on Management of Uncontrolled Hazardous Waste Sites, 1982. Available from Hazardous Materials Control Research Institute, 9300 Columbia Blvd., Silver Spring, MD 20910.

APPENDIX B

Figures

Figure 1: Universal Bung Wrench

SOP #2009

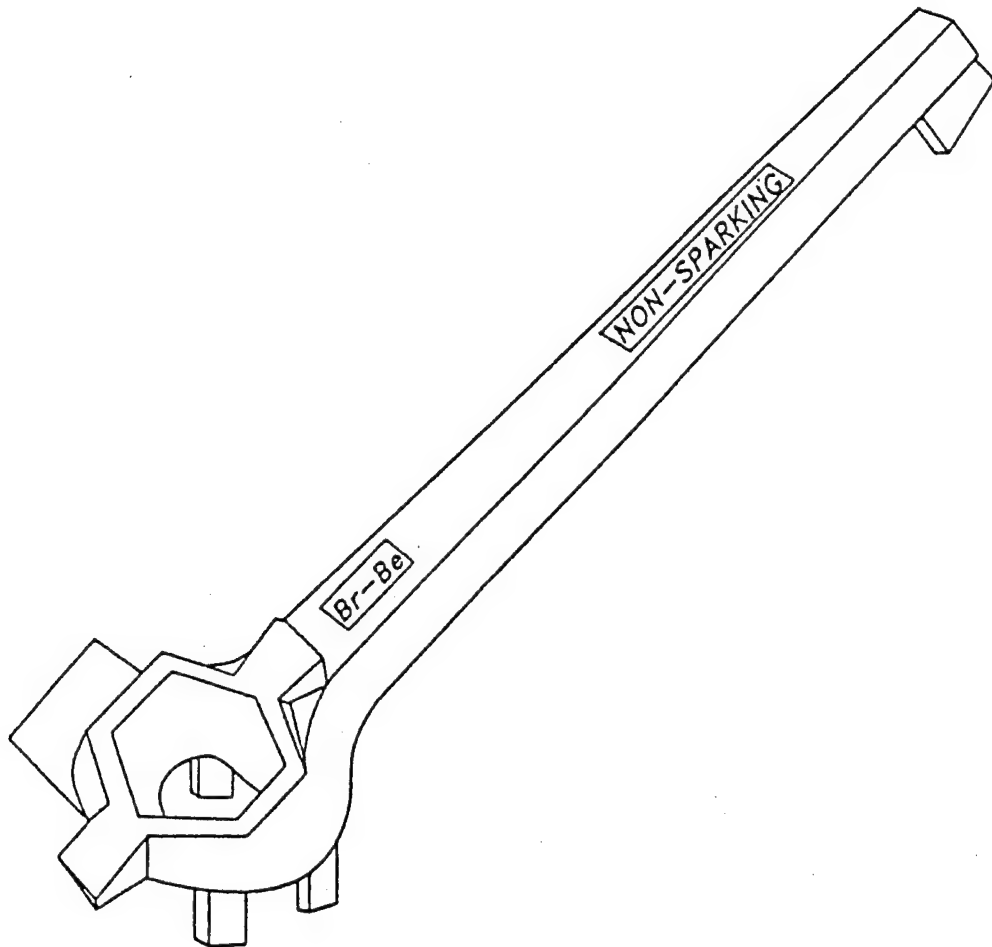


Figure 2: Drum Deheader

SOP #2009

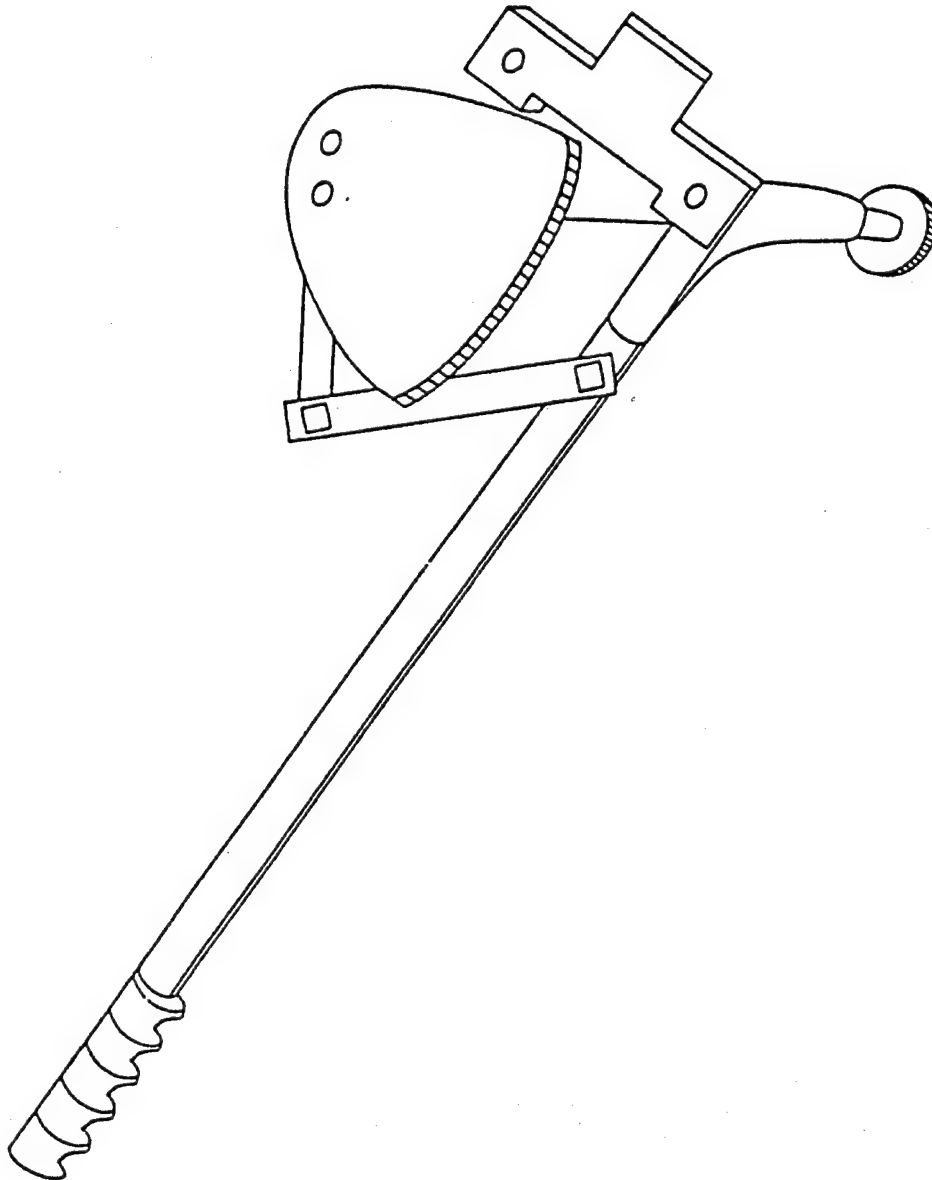


Figure 3: Hand Pick, Pickaxe, and Hand Spike

SOP #2009

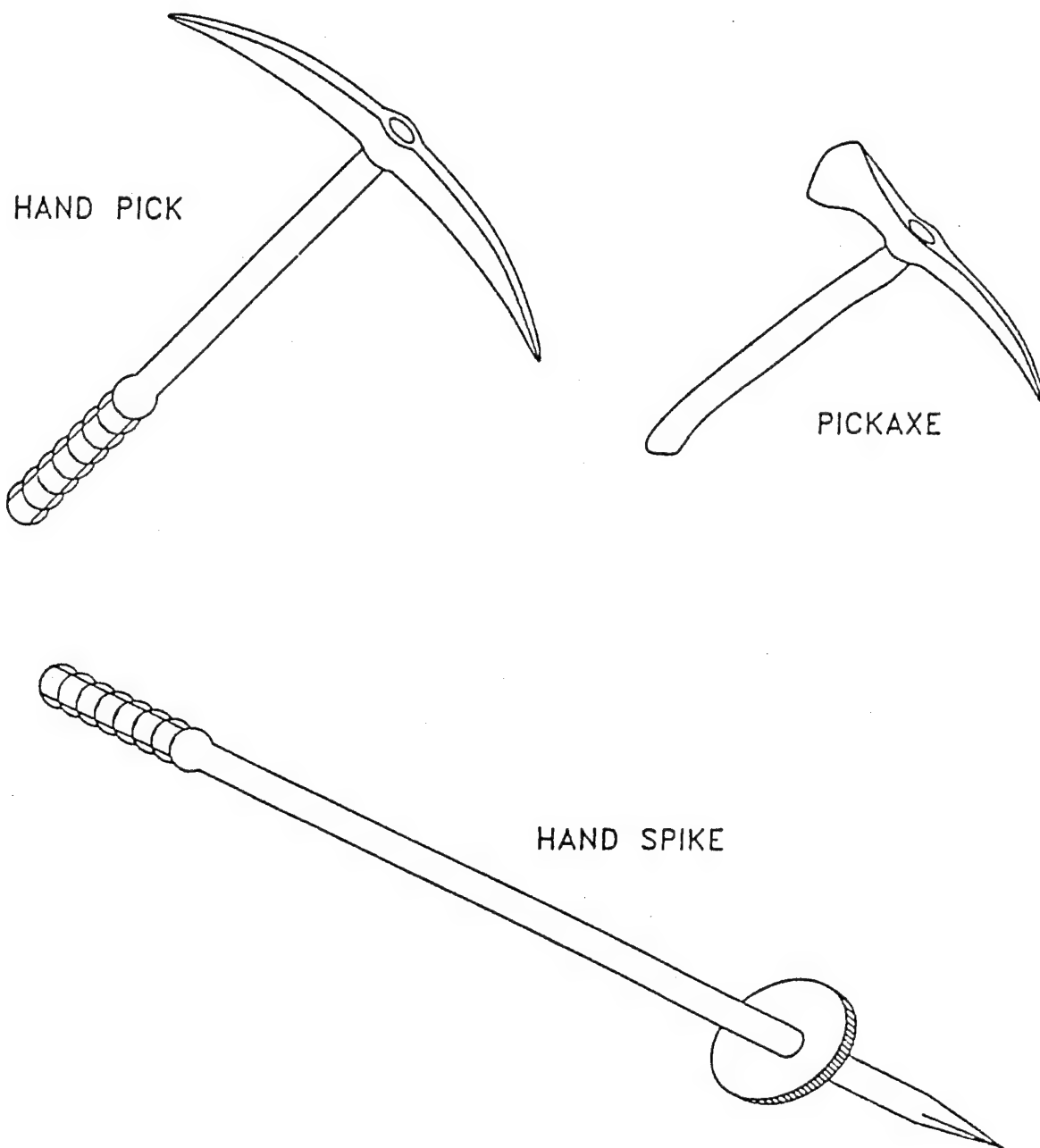


Figure 4: Backhoe Spike

SOP #2009

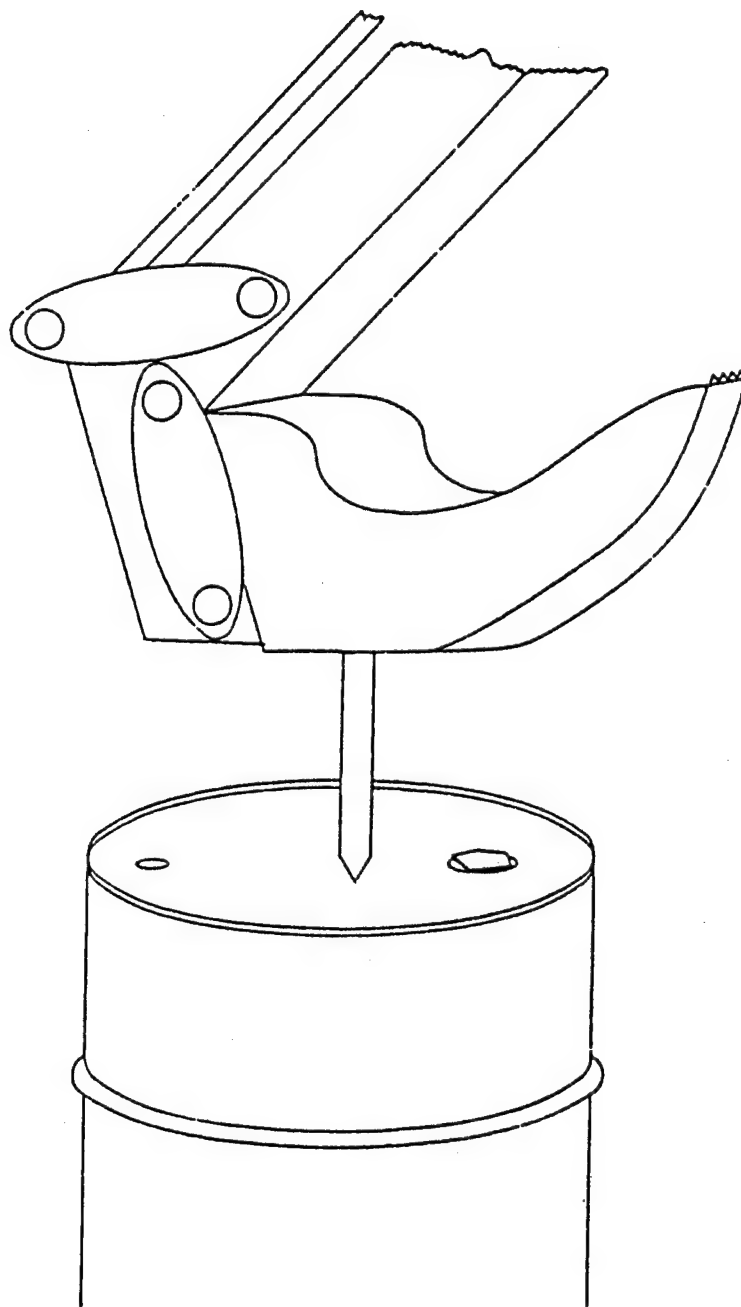


Figure 5: Hydraulic Drum Opener

SOP #2009

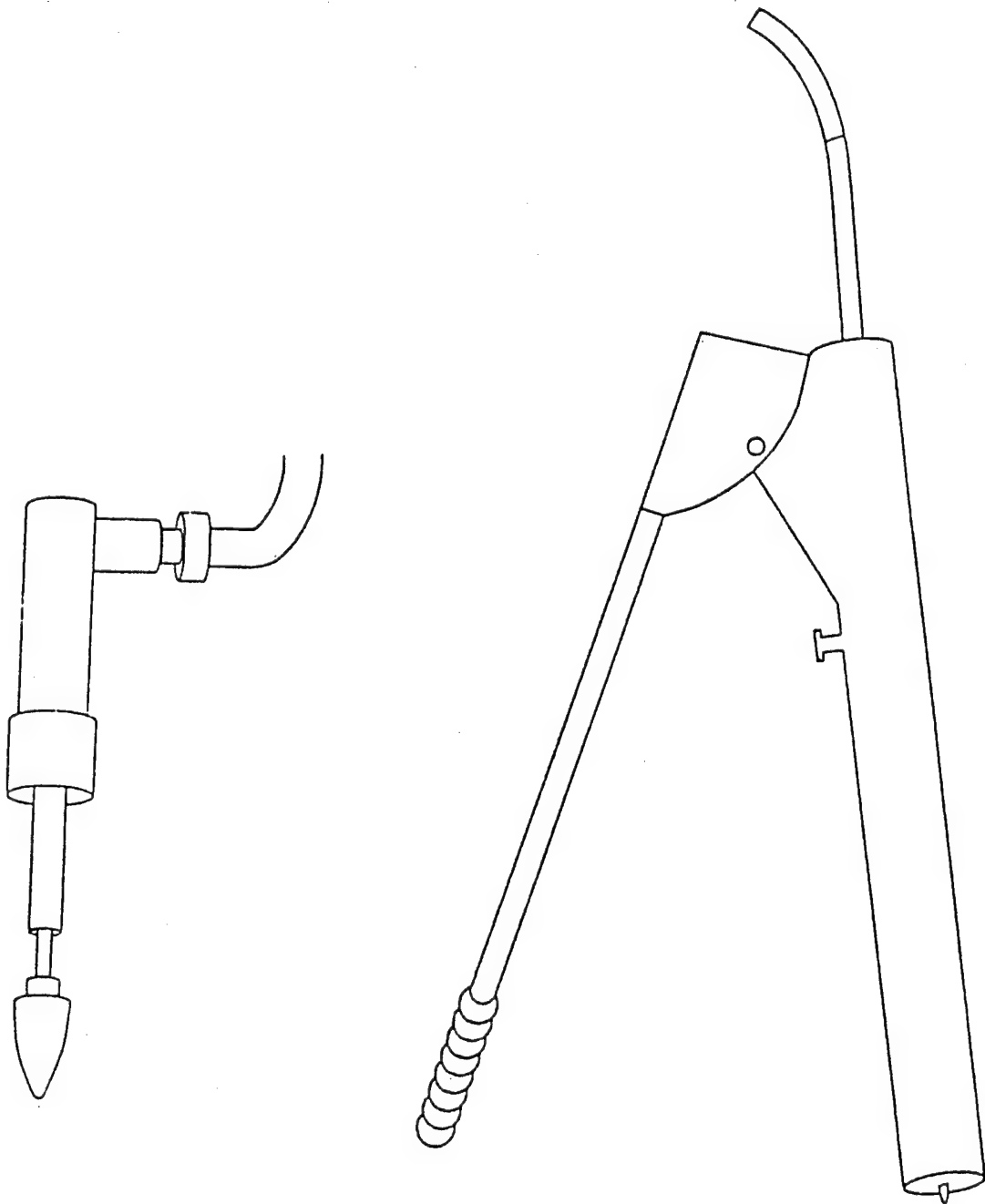


Figure 6: Pneumatic Bung Remover

SOP #2009

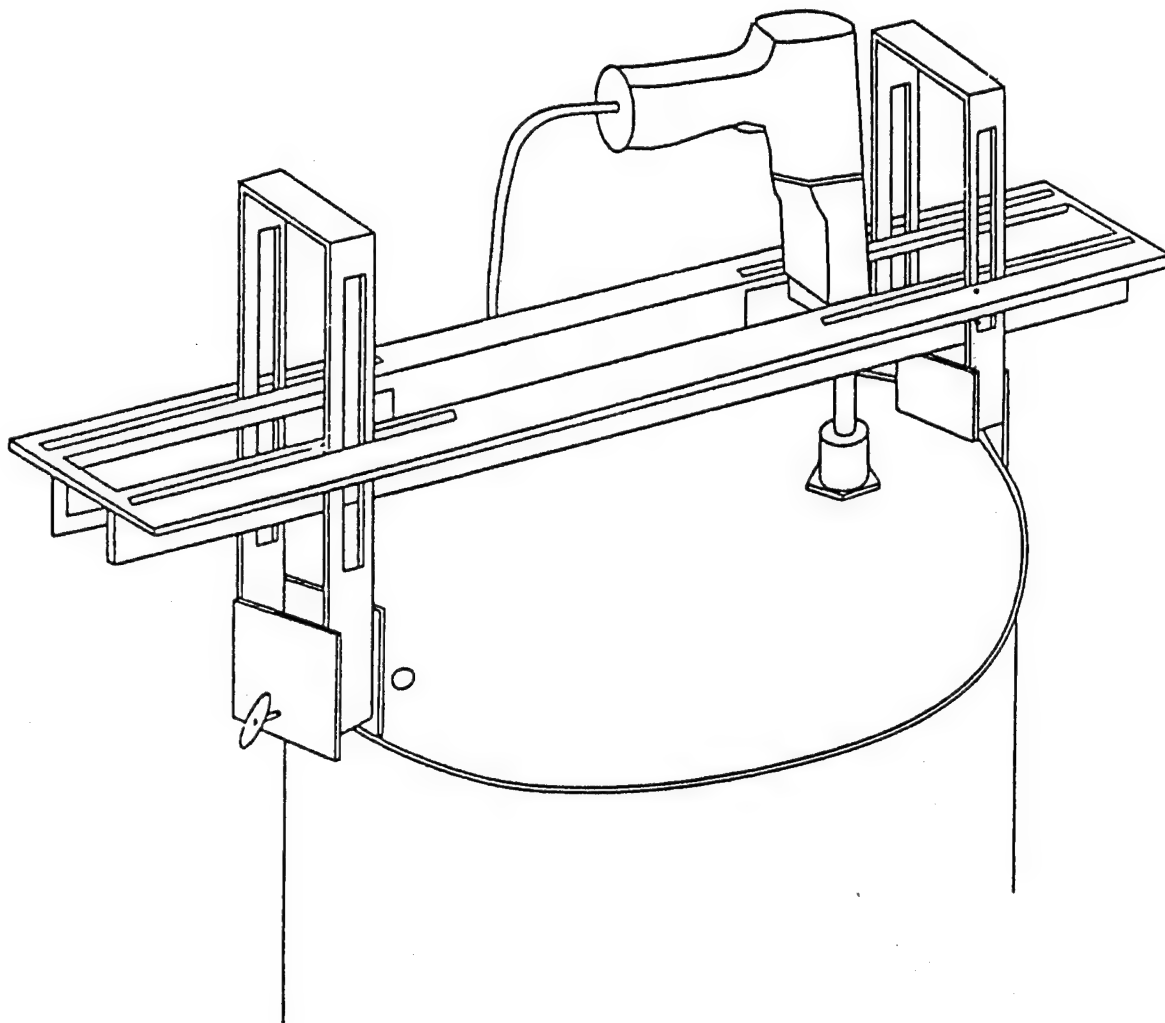
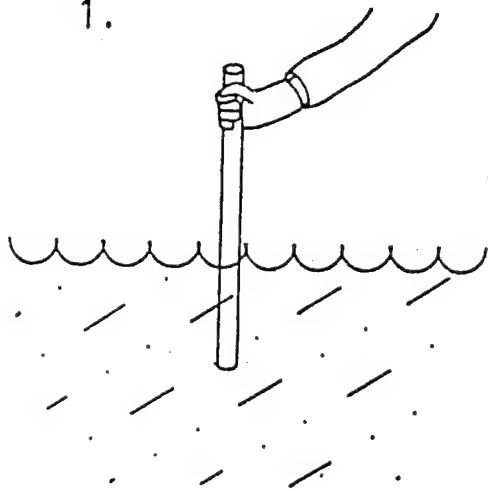


Figure 7: Glass Thief

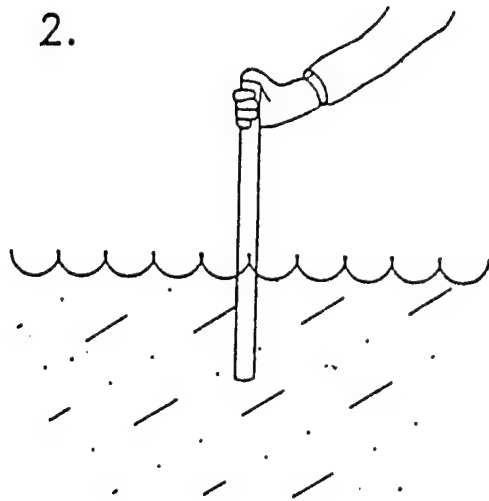
SOP# 2009

1.



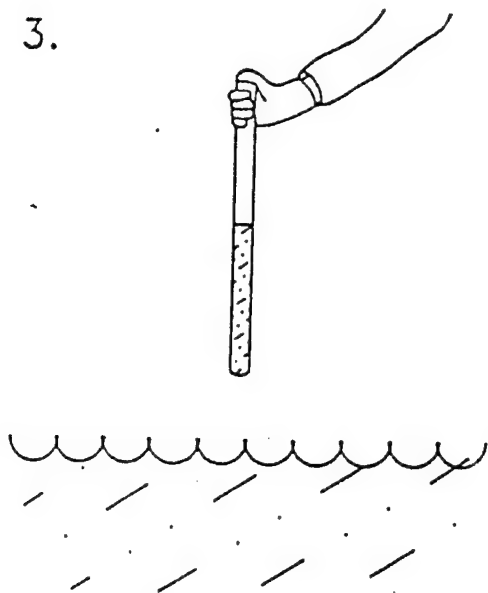
Insert open tube (thief) sampler in containerized liquid.

2.



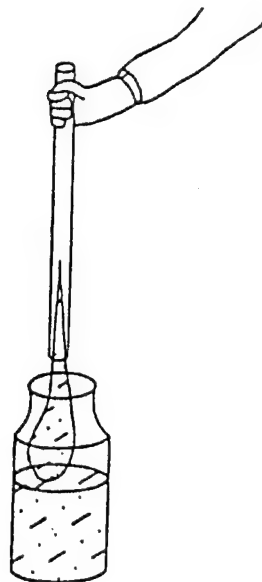
Cover top of sampler with gloved thumb.

3.



Remove open tube (thief) sampler from containerized liquid.

4.



Place open tube sampler over appropriate sample bottle and remove gloved thumb.

Figure 8: COLIWASA

SOP #2009

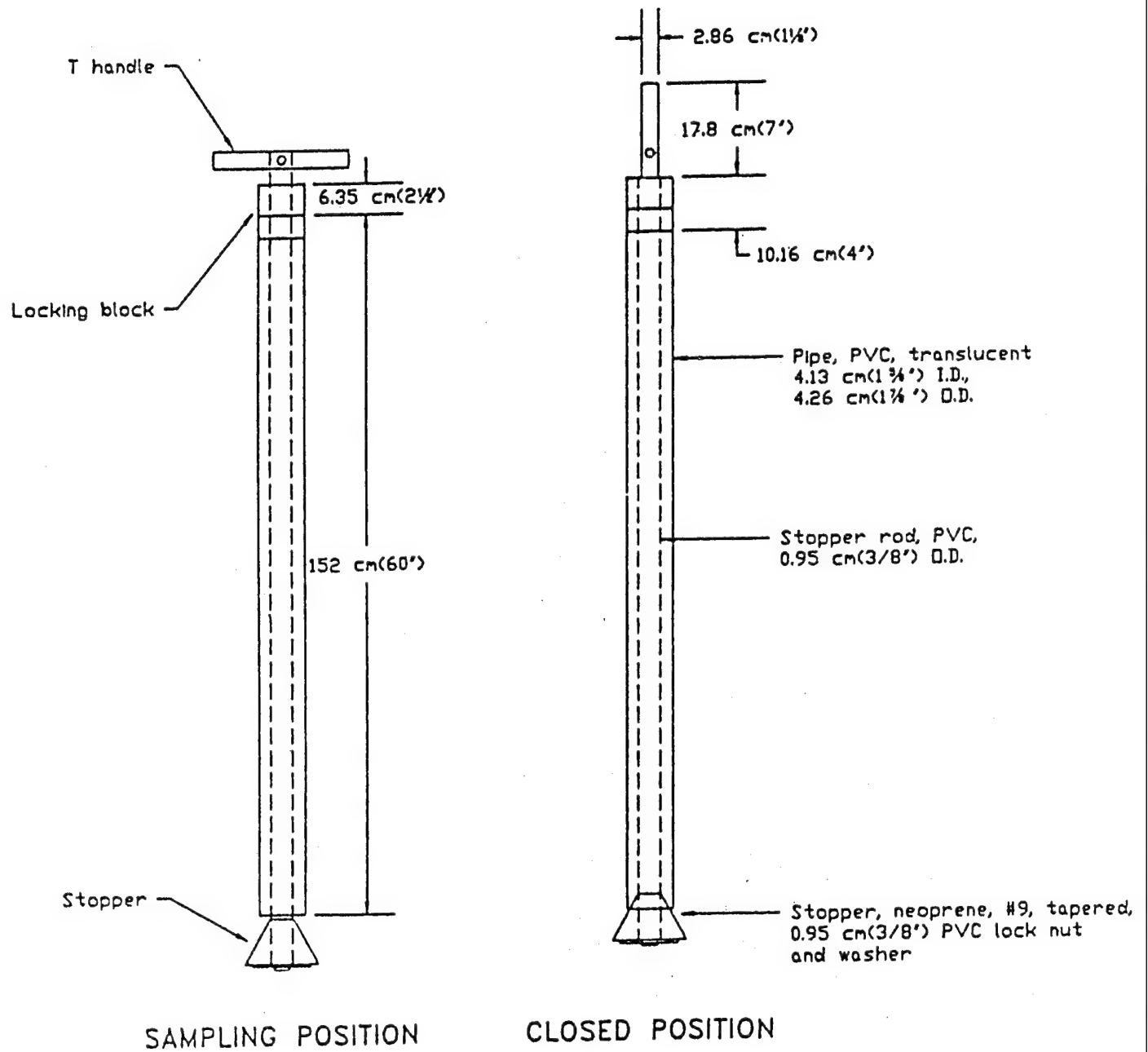


Figure 9: Bacon Bomb Sampler

SOP #2010

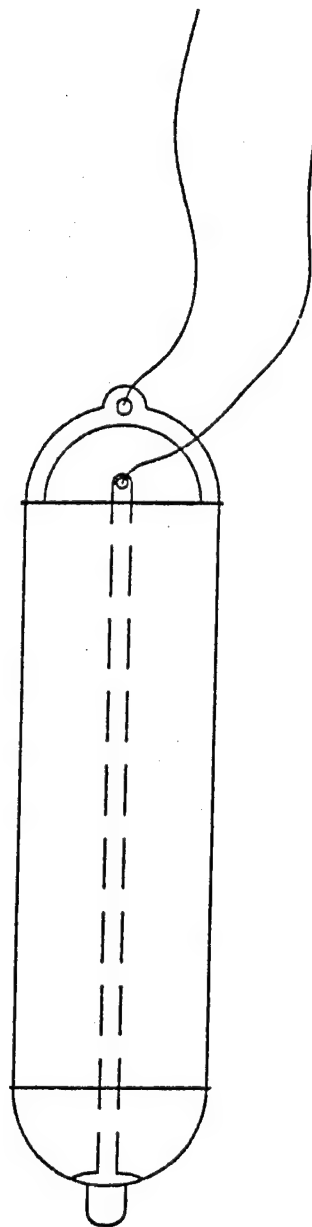


Figure 10: Sludge Judge

SOP #2010

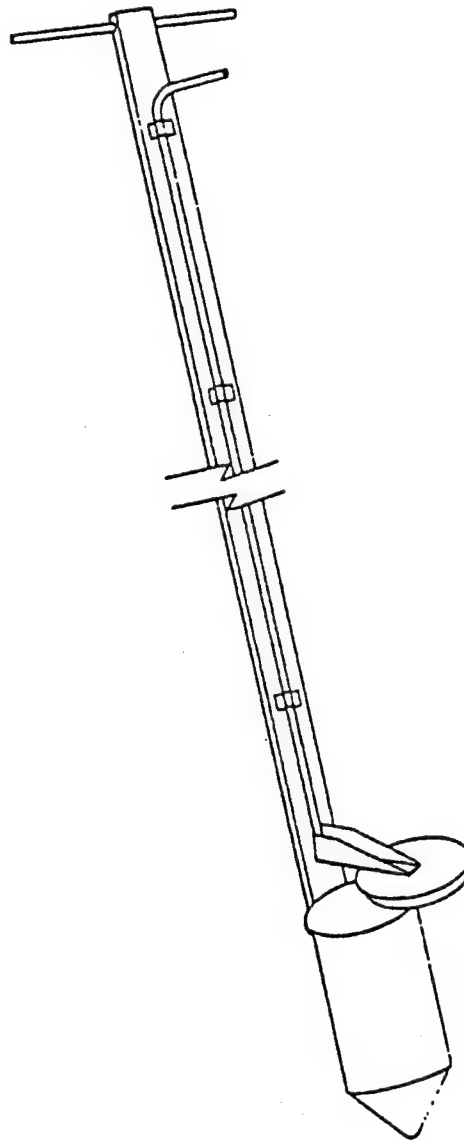


Figure 11: Subsurface Grab Sampler

SOP #2010

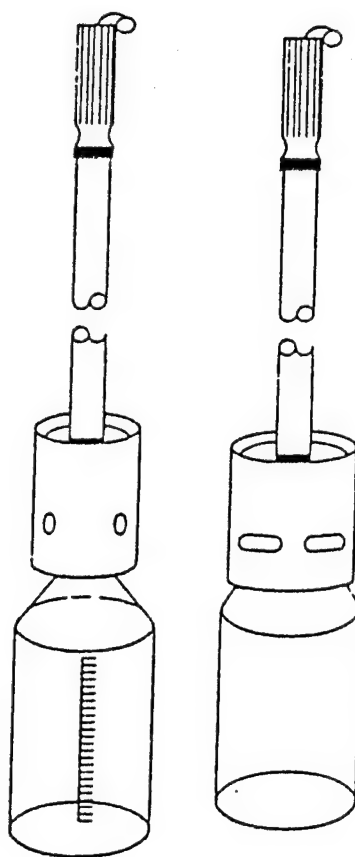


Figure 12: Bailer

SOP #2010

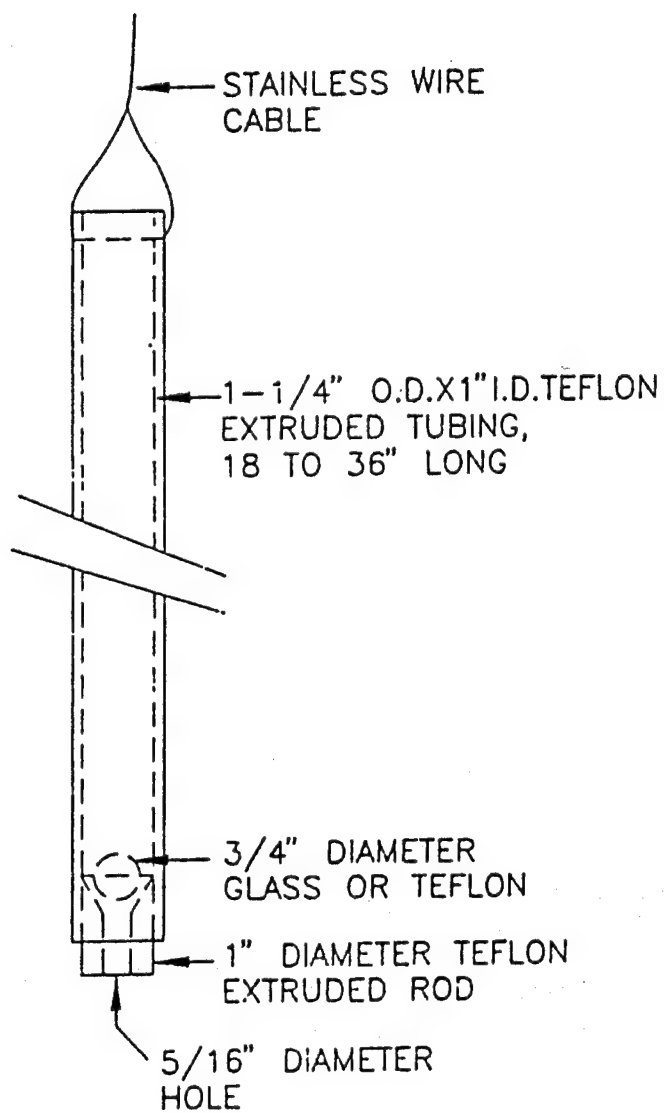
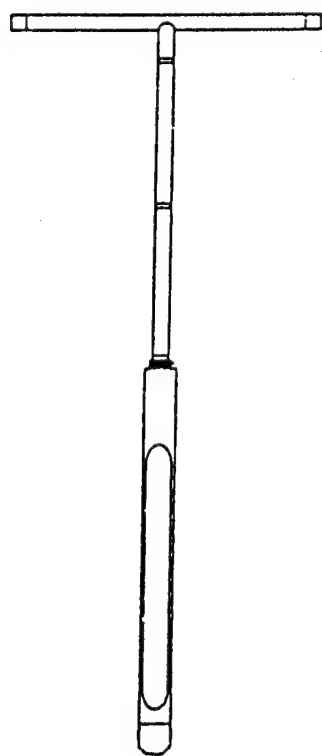
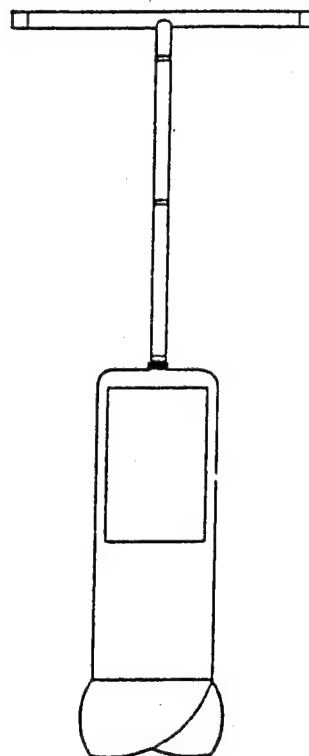


Figure 13: Sampling Augers

SOP #2017



TUBE
AUGER



BUCKET
AUGER

Figure 14: Sampling Trier

SOP #2017

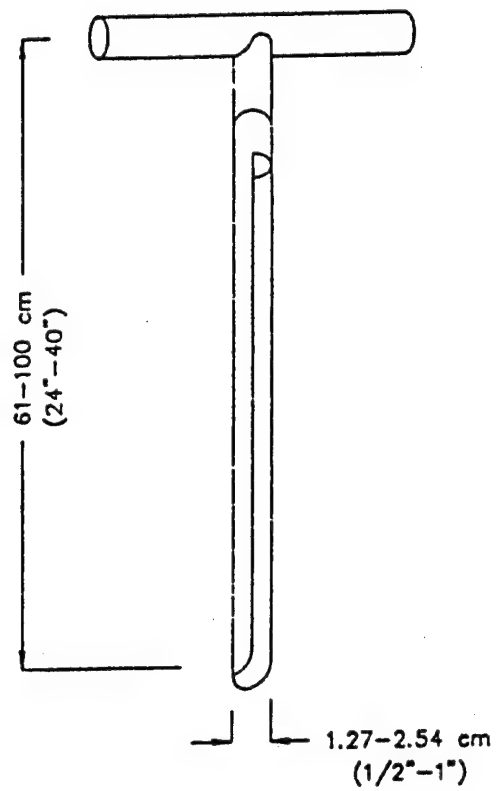
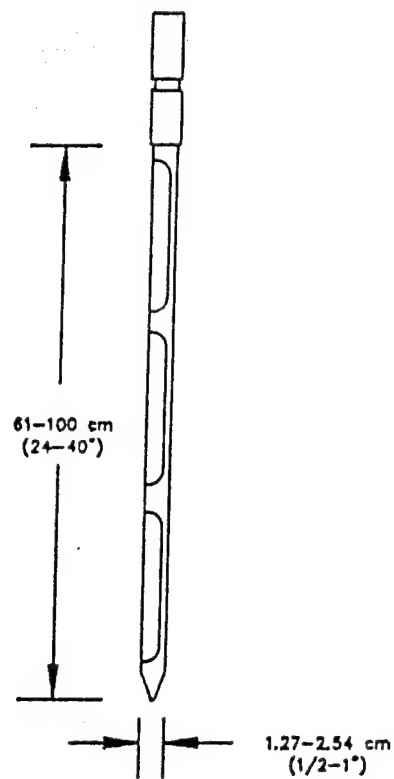


Figure 15: Grain Sampler

SOP #2017



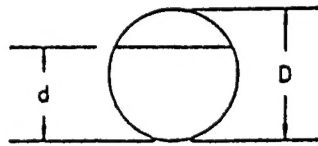
APPENDIX C

Calculations

Various Volume Calculations

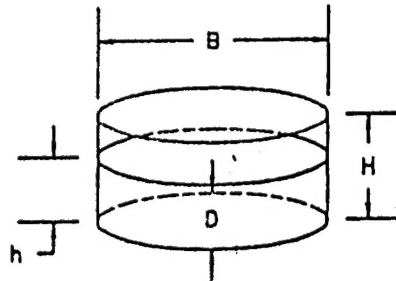
SOP #2010

SPHERE



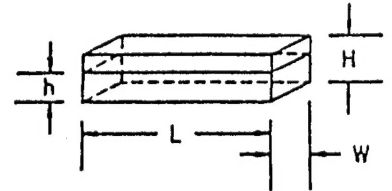
Total Volume
 $V = 1/6 \pi D^3 = 0.523498 D^3$
 Partial Volume
 $V = 1/3 \pi d^2 (3/2 D - d)$

ELLIPTICAL CONTAINER



Total Volume
 $V = \pi B D H$
 Partial Volume
 $V = \pi B D h$

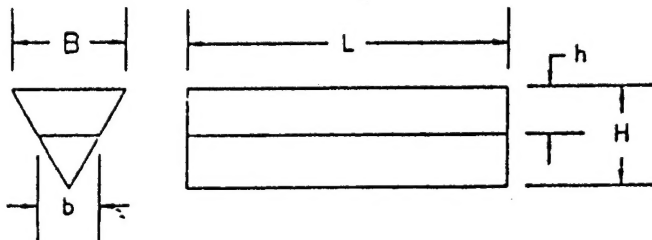
ANY RECTANGULAR CONTAINER



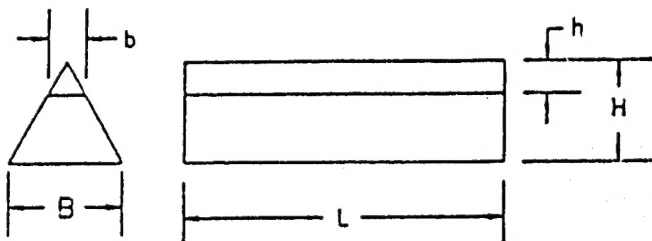
Total Volume
 $V = H L W$
 Partial Volume
 $V = h L W$

TRIANGULAR CONTAINER

Total Volume:
 $V = 1/2 H B L$

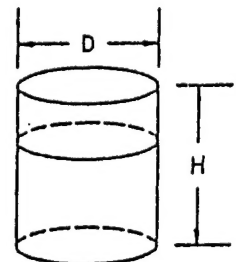


Case 1
 Partial Volume
 $V = 1/2 h B L$



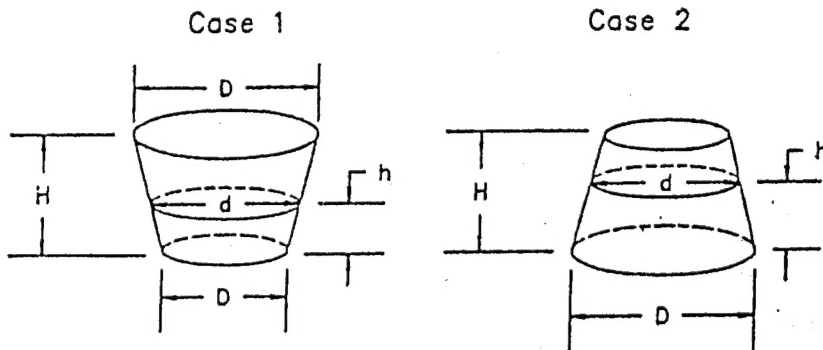
Case 2
 Partial Volume
 $V = 1/2 L (H B - h B)$

RIGHT CYLINDER



Total Volume
 $V = 1/4 \pi D^2 H$
 Partial Volume
 $V = 1/4 \pi D^2 h$

FRUSTUM OF A CONE



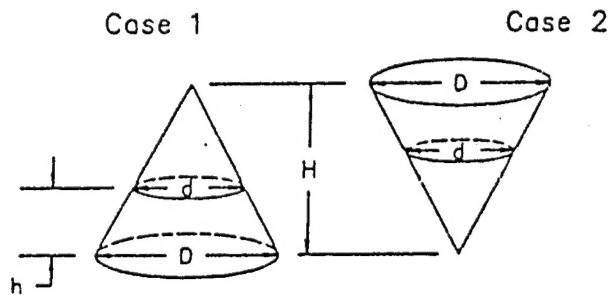
Total Volume

$$V = \pi/12 H(D_1^2 + D_1 D_2 + D_2^2)$$

Partial Volume

$$V = \pi/12 h(D_1^2 + D_1 d + d^2)$$

CONE



Total Volume

$$V = \pi/12 \cdot D^2 H$$

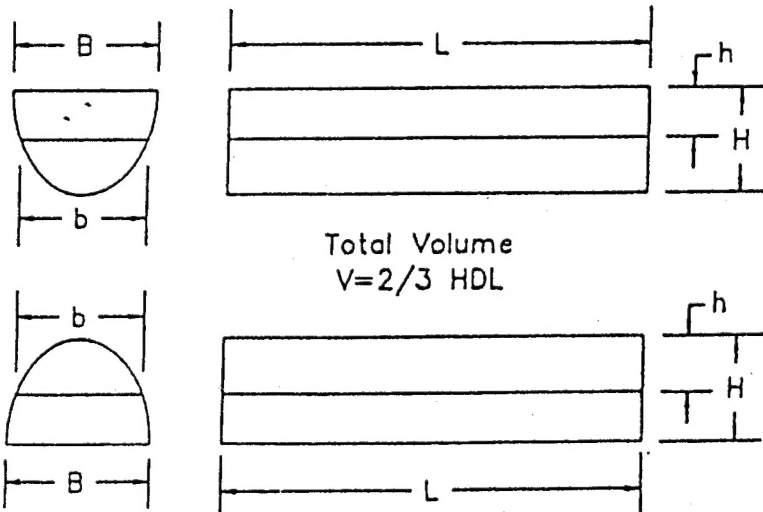
Partial Volume Case 1

$$V = \pi/12 \cdot d^2 h$$

Partial Volume Case 2

$$V = \pi/12 \cdot (D^2 H - d^2 h)$$

PARABOLIC CONTAINER



Case 1

Partial Volume

$$V = 2/3 hdL$$

Case 2

Partial Volume

$$V = 2/3 (HD - hd) \cdot L$$

References

- Illuminating Engineers Society. 1984. IES Lighting Handbook. New York, NY. eds. John E. Kaufman and Jack Christensen. (2 volumes).
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